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DISCOVERY

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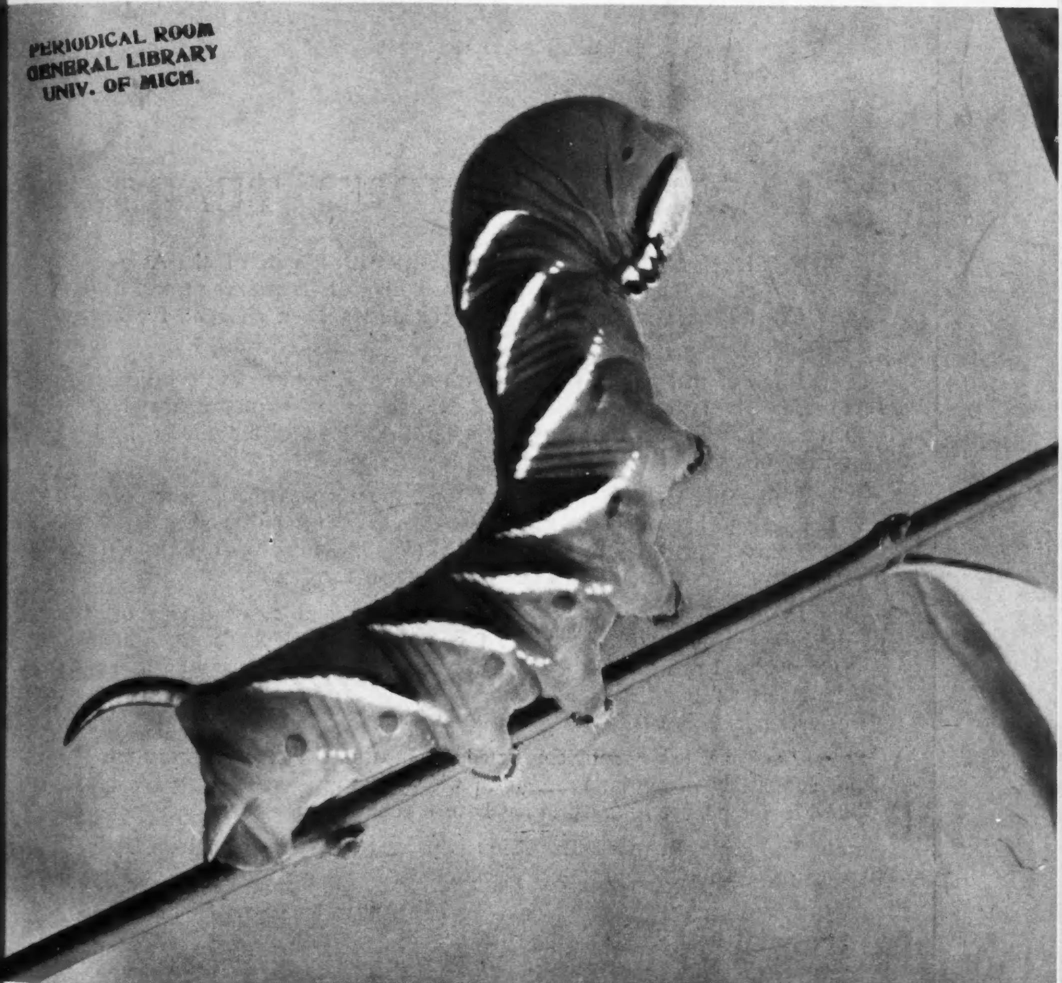

- Mr Tompkins in Wonderland: 5th Dream
- A NEW KIND OF ATOM-SPLITTING
- The Size of the Universe
- The Action of Strychnine
- Coast Erosion

DISCOVERY

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The First Excitement That Knowledge Gives

MOST of us can remember the first time we heard or read something which seemed to throw a new light upon the world. In my own case, it comes back with extreme clarity. I was a child of eight or nine, and I had got hold of a bound volume of Arthur Mee's *Children's Encyclopaedia.* It was a dark afternoon, and I was sitting by the fire. Suddenly, for the first time, I ran across an account of how atoms were supposed to be built up. The article had been written before Rutherford had discovered the nucleus, although by the time I read it the nuclear atom must have been well known. However, I was innocent of all that, I had never seen the word "atom" before; this article—it was quite short and was contained, I think, in a section called the Child's Book of Wonder—explained that its descriptions were only a guess, that no man knew the truth, and yet it seemed to open up a new sight of the world.

It told me that if you could go on cutting up any sort of material, you would arrive at atoms in the end. These atoms were so small that no one would ever see them and you could crowd countless millions on to a pin point. There were different sorts of atoms: and yet, if you cut up the atoms themselves, you found in some mysterious way that they were made of the same stuff. That idea probably came more easily to a child than to an adult, and I swallowed it whole.

The actual description of these atoms was rather quaint, in the light of later knowledge. Small as they were, they were packed with much smaller things called electrons (which, of course, had been known about since J. J. Thomson's work in the nineties). According to the article, these electrons were like tennis balls in

a cathedral; and, again according to the article, the tennis balls were in violent and random motion across the interior of the cathedral. It is a little difficult nowadays to see how that picture was ever conceived; I found it very easy to unlearn a few years later.

Yet, though so much of that article could not endure, it gave me the first sharp mental excitement I ever had. Somehow it gave me the heightened sense of thinking and imagining at the same time. And one is lucky if those exalted moments visit one more than ten or twenty times in a whole life.

Addition to the Policy of "Discovery"

In these days the same excitement must come to many people through science. And that fact suggests that in one important aspect *Discovery* has been failing in its duty. We have tried to keep intelligent readers, without special equipment but *already interested in science*, in touch with the latest developments. That we still regard as our most valuable function; for example, we think that Professor Gamow's brilliant and individual exposition of modern physics could not be better found in any other journal in the world. We are taking a further step in making sure that we can give the latest authoritative scientific news: for a whole team of volunteers has now been organized in order to contribute to "Notes of the Month". Each of them is himself an expert, engaged in active research, and when exciting news occurs on his own front he will dispatch it to *Discovery*. In this way we hope to make our "Notes of the Month" the most up-to-date account of the latest scientific news for those not able to read the original papers.

But we feel also that we ought to do something we have not yet done. We ought to try to bring the excitement of science to those not already interested, particularly to the young. We should like to give a certain number of readers their first thrill at catching a glimpse of a new world. With this in mind, we are making an addition to our policy. We shall publish each month an article whose subject matter is considerably easier than our ordinary run, an article specially designed for someone who has not yet begun to read any scientific accounts whatever. This month, we are including an article by Michael Lorant on "The Size of the Universe" with this intention. Sometimes our "inviting" article will be on practical applications, sometimes, like this first one, on atoms and stars. For people, of course, are led to science by different paths.

As far as possible, this article will always be the last in the number, immediately in front of the reviews.

C. P. S.

How Stained Glass is Made

The Modern Development of an Ancient Craft

By N. W. Gregory Walker

THE term "stained glass" is applied to windows in which the design is made by pieces of already coloured glass, the detail and most of the shading being obtained by added painting in one tone.

The art probably dates from pre-Norman times, and is fundamentally the same to-day as it was in the twelfth century. Modern improvements are found in the greater range of textures and colours obtainable and in certain technical aids. It may be said at once that there are no lost secrets. Any glass known to medieval craftsmen can be reproduced to-day.

Two main improvements are the gas oven, for firing the painted glass, and the cutting-wheel. Under the old system of firing the workman made what he considered was a proper fire, left the glass for 24 hours, and trusted to luck, which often deserted him and spoilt hours of labour. The modern process is a matter of minutes, and the glass is always on view through a small window. The medieval craftsman did not even have a diamond, but split his glass with a hot iron. Sometimes he got the split where he wanted it, at other times his work was ruined or, at best, he was driven to putting a lead strip in the wrong place, and so injuring his design.

All stained glass is blown, as it has been for hundreds of years. To all intents the artist in this medium works with translucent precious stones, and the greater the variety in these that he is given the more he can do. Hand-made glass has life in it; "perfect", machine-made glass is, for the artist, dead.

Following immemorial practice, then, the molten glass is blown into a bubble. Usually this is lengthened and the ends cut off to form a cylinder. After being cracked down one side, it is resoftened so that it may be opened out. Formerly (after being split with a hot iron) it was laid on a stone, leaving the underside rough. It is now laid on plaster of Paris or on a sheet of asbestos, and there is little to choose between its upper and lower faces. Often the glass bubble is blown inside a box, in the fashion of a case-bottle. Where it touches the centre of each side of the box it clings, and then thins out as the blowing drives it into the corners. Each sheet, therefore, when the cube is snapped into rectangles, is thickest in the middle. Then there is crown glass, where the bubble is twirled until it forms a disc, also thinning towards the edges, with whirls breaking the surface.

These variations in thickness and texture are invaluable for the artist, and there are further processes still. "Flashed" glass is made by dipping a lump of melted glass (pot metal) into another kind of glass before blowing. A solid ruby or blue glass, if blown as it stands, would show almost black. A lump of white glass is therefore dipped into ruby or blue, so that, when blown, the colour is no more than a film. Besides being translucent, these flashed glasses, of different colours, may be treated with acid, so that they can be shaded down to white, or to give a desired pattern—say diaper work or foliage. The lovely streaky glasses, again, are made by slightly stirring two colours together before they are blown.

The colours come from oxides, chiefly those of iron and copper; uranium gives yellow, cobalt gives blue. The most precious glass made—a particular red—is got from oxide of gold. A modern discovery is of a red from selenium. The variations

Cutting the glass to shapes determined by the Cartoon

obtainable from one metal are astonishing, and are largely a matter of firing. Thus copper normally gives a range of blues and greens, but may be fused until it yields a ruby. Gold ruby, melted to 1300° C., becomes white; brought back to 500° it turns red, but beyond that it makes a coppery green.

There is only one oxide that will stain glass after it is made, and that is silver, which gives a permanent yellow. The glass-worker's story is that a monk dropped a silver button upon his glass which, when he removed it from the kiln, he found to be covered with a yellow stain. This fourteenth-century discovery, by giving glassworkers a colour to *paint* with, went far towards spoiling glass staining, for the cheap effects of the new technique were badly abused.

Before dealing with the actual making of a window, it must be emphasized that, from first to last, the artist needs to think in terms of light. He should make every effort to see the church or hall in which he is to put his window. Buildings or trees may be just outside it. If, for example, it is on the north wall, a stream of light may cross the interior of the building from the south and strike his window on the wrong side. Similarly chancel lights may spoil an east window, if they are not allowed for. Light, again, is always changing. Blues sink in

Assembling the cut shapes of glass and uniting them with lead strips

a brilliant light, but reds come up. Thought should be given to the time of day when the window will be most seen. There is now being made in London a window that is a mass of rich reds and blues. It is a glorious piece of work, though it would never do for England, if light is wanted; it is going to New Zealand. No coloured sketch—certainly no photograph—can give more than a suggestion of the effect of a window in position. It is an interesting point, that, in a dull light, a stained glass window becomes brilliant if looked at reflected in a mirror.

Apart from the all-important light, what should the designer consider? First, if he knows anything of his medium, he will not attempt to make a picture but, rather, let his design give the effect of a mosaic. Transparency will do nothing for a picture, which, in any case, is in its proper place when on a wall. A window is part of the side of a building, and so is an architectural feature, to be treated as such. It therefore needs restraint and careful balance in design. Figures shown in quick movement, picture fashion, will make the whole design appear restless and out of place, lacking in dignity and repose. There is no need to fear that "life" will be lost. A good window almost speaks, for the sun catches odd panes here and there and sets them quivering.

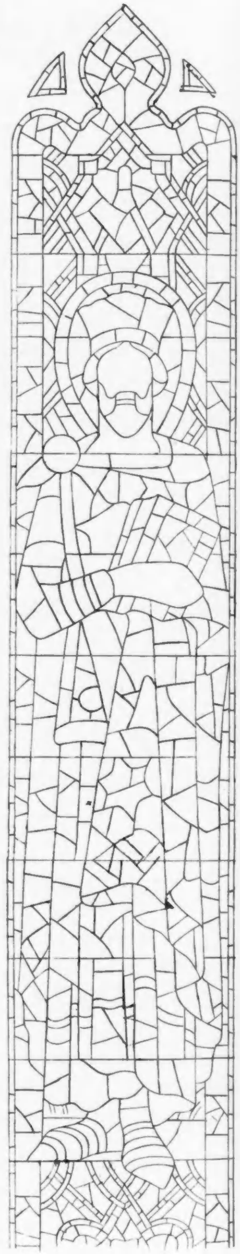
If the cartoons for the great windows of Liverpool Cathedral are looked at from a

The Cartoon

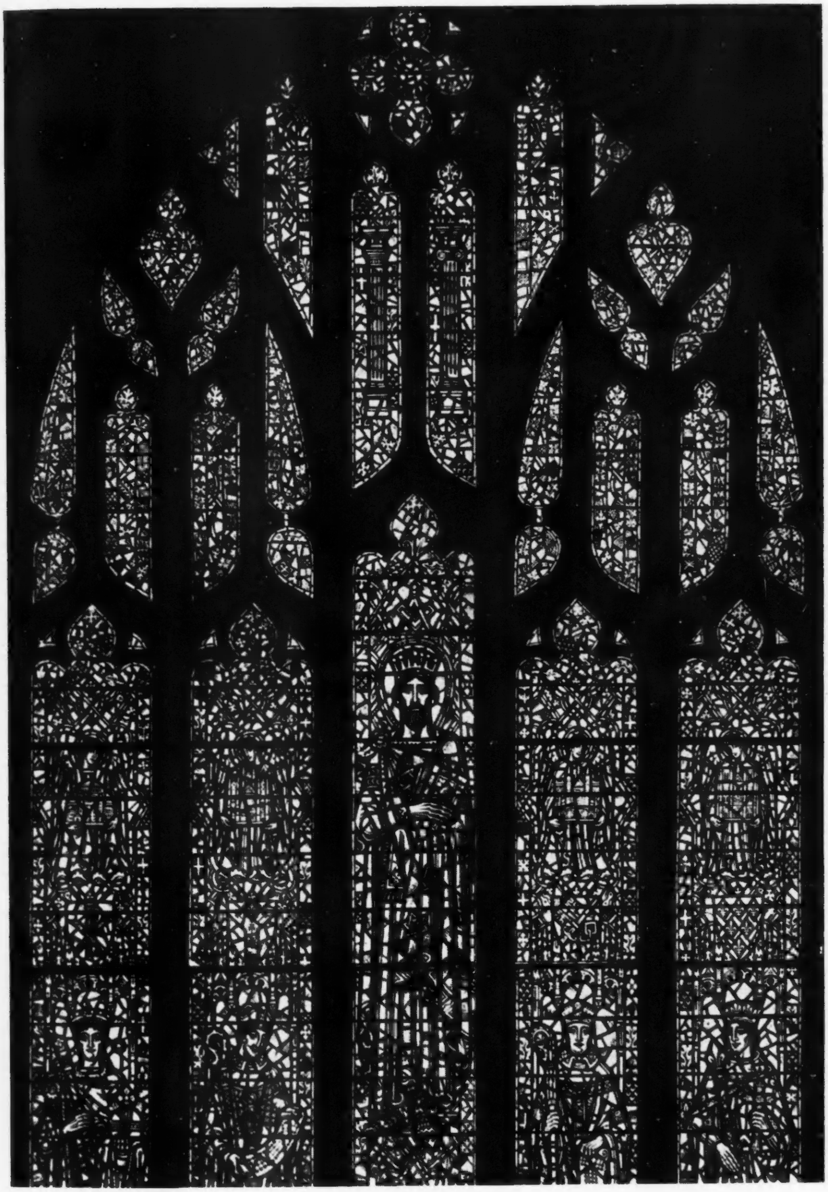
few feet away, they appear as a trellis of broad black lines, among which it is hard to make out the design. Now, light passing through a small piece of glass, surrounded by leads or other solids, glows, so that it seems to "eat away" the leads. The Liverpool window is seen at a distance of 60 or 70 ft., where the halation will reduce the leads to the finest lines. That is why they are from half an inch to an inch broad. If this were not so they would apparently disappear; and pronounced leading is an integral part of a window's design.

In the process of making a window the artist first makes a *sketch*—usually on the scale of an inch to a foot. The sketch is then enlarged into a *cartoon* (left), which is a drawing, usually uncoloured, showing the window full-size. Cartoons for large windows must, of course, be done in sections. Next is made an *outline* (right), showing nothing but the position of the lead strips, the breadth of the lines being that of the cores of the leads, apart from their flanges which will overlap the edges of the glass.

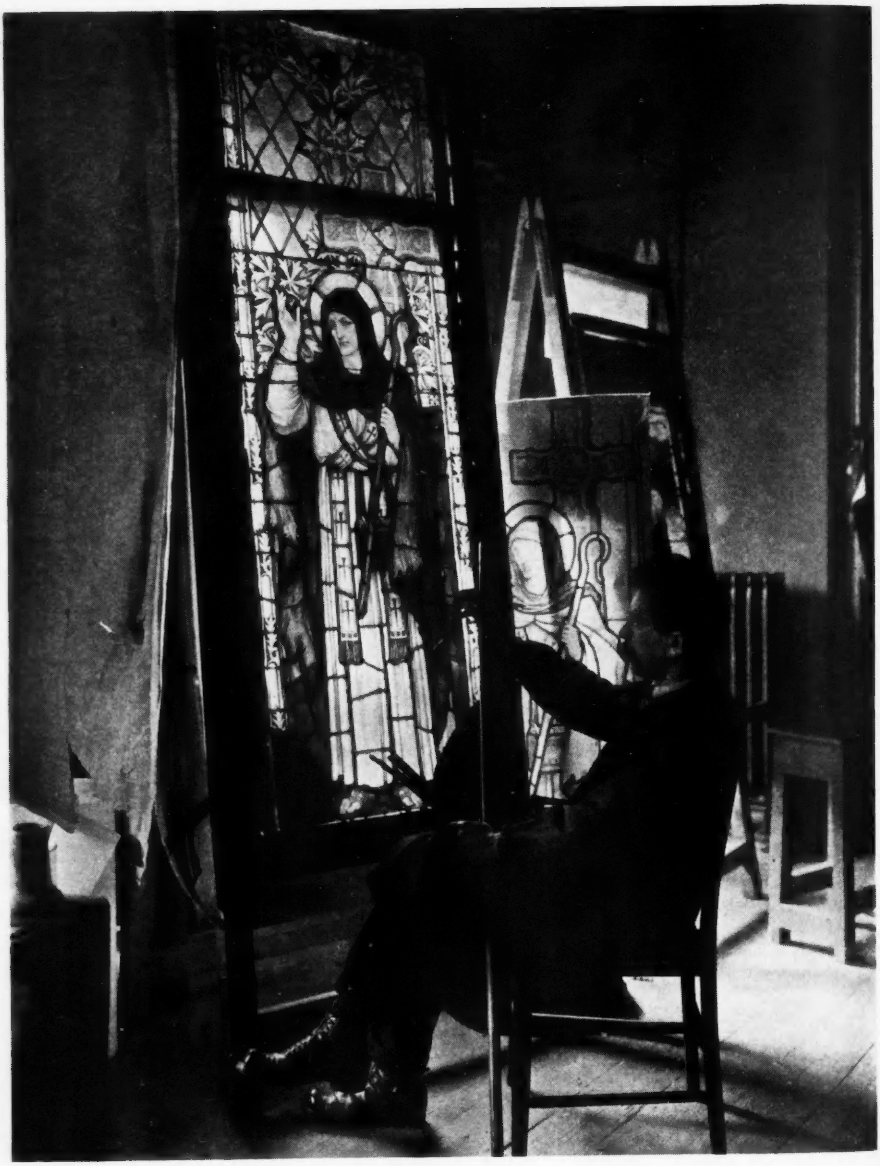
The *cutting* is done on the guide given by the outline, and nearly always with a wheel. What is necessary is a cut and not a deep ripping scratch, which splinters the glass sideways and will not break so well. The downward pressure of the wheel starts a crack which the craftsman deepens by tapping on the underside, when the glass almost falls apart. Deep curves must be taken out in small pieces, either with the aid of pliers or of the grozing iron, which catches the glass in a slot and snaps it off. Even to-day there are artists who, ignorant of the limitations of glass-cutting, design



The Outline



Photograph of part of the completed window



Painting the pieces of glass which are fixed by wax on to a framed sheet of plate glass

windows which it is impossible to make. In any case about two-thirds of the glass is cut to waste, but some of this is remelted for future use. It is during the cutting that flashed glass is, when so desired, acidified out with hydrofluoric acid.

When the colour scheme is satisfactory there comes the *waxing up*, by which the pieces are reassembled on a sheet of plain glass and stuck to it with a dab of hot wax at their corners. The window is now a pure mosaic, and, when set upright on an easel with the light passing through, is ready for *painting*, which consists in filling in features and other detail, besides any shading that is required. The pigment used, of one colour only, is made of powdered glass melted and combined with an oxide of copper and iron. It may be so deepened as to become black and opaque. Shading is usually done by laying a wash of pigment, a "matt", and brushing this down or hatching through it with almost any sort of tool that the artist fancies; it may be bristles, a wooden point, a sharpened needle, a quill; or he may use his thumb. Another method of shading is by stippling with the end of a brush.

The painted pieces go to the *firing*, when they are brought in the oven to a heat of 400–500° C., at which temperature the pigment sinks in and has the same life as the glass, of which it becomes a part. At any stage of the painting a piece may be detached from the easel and fired or refired until the artist is satisfied with it. The glass to be fired is laid in a shallow tray filled with firmly pressed plaster of Paris. Finally the glass is passed, for *leading*, to a workman who lays the pieces on the outline and sets them into the lead strips which, with an electric iron, he solders at every join. Cement is worked under the flanges to make the window watertight, and copper wire is soldered to the lead, ready for twisting round the bars that will brace the window.

There is an idea that stained-glass windows should not be cleaned. Mr James Hogan, who designed the great windows just set up in Liverpool Cathedral, the tallest lights ever made, says emphatically that they should be; not with soda, but with soap and distilled water. In designing the Liverpool windows he allowed for a smoky atmosphere, but he meant them to be seen new.

Apart from the destruction of colour effect by a deposit of grime, even glass can quickly be injured by acids. In a city the carbonic acid from petrol fumes leaves an oily film on glass which no rain will wash away, and this again attracts the sulphuric acid from coal smoke. But the figures of saints and martyrs, enshrined in jewellery of flame and violet and ruby, are surely worthy of some care.

Long Before Darwin

Linné's Views on the Origin of Species. II

By Gabrielle Rabel

THE proof that plants had sex caused a revolution in botany. Linné could definitely state that every flowering plant possesses masculine and feminine "genital organs"—the anthers were called testes—and later, owing to his crossing experiments, he not only established the fact that fecundation is necessary to reproduce offspring, but also made it clearer of what the act really consisted.

We can describe the condition prevailing at that time in his own words: "The adherents of Harvey tell us that the foetus is prepared in the egg of the mother and the male liquor only operates a chemical, or, as some modern physicists say, electrical, stimulus on it. The pupils of Loewenhouk, on the contrary, assert that the egg yolk is nothing but a cave wherein the 'worm' settles down to form an embryo. *I am afraid*

that neither of the two opinions is correct. I have seen the little bodies in the male liquid which Loewenhouk calls worms, and I am convinced that the fertilization is due to them. But I am not convinced that they are living and 'worms'..."

From the difference in the appearance of mules, according as to whether the horse is father or mother, he first drew the conclusion that both parents have equal shares in the reproduction of the offspring. And in his plant experiments he could demonstrate this fact clearly.

The discovery of the *Sponsalia Plantarum*, however, was not a feat of the type which only concerns scientists. It exercised an enormous charm on poets, artists, and philosophers: I need mention only Rousseau, Matthisson, and Goethe. The German poet Matthisson marched out into the Swiss mountains, Linné's book in the pocket of his coat, and as he plunged into the Alpine flowers to approach the mystery of their "fructifications", he was feasting and revelling on the sweetest and most amazing discoveries—a pleasure which even to-day, every novice who starts opening flowers and studying them will enjoy as well. Another poet brought the fascinating doctrine of "plant weddings" into verses which are supposed to have inspired Goethe to his hexameters on the "Metamorphosis of Plants".

However overwhelming was the success of Linné's sexual system of classification, he himself later on various occasions emphasized that it was only an artificial system. The "artificial system is only for diagnostic purposes, but the natural I cannot accomplish, even if I should spend my entire life on it. I cannot separate the natural families." It was, in his opinion, the real aim of botany to establish, or, rather, to discover the "Natural Methods"; fervently and assiduously was he searching for it, and pathetic are his repeated complaints that he could not achieve it. His lectures, however, published later by Fabricius and Gieseke, were based on the Natural Method. Gieseke's book contains a kind of map which tries to show the relations between various families, and at the same time demonstrates that such relations cannot possibly be described by words. One of Linné's pupils imagined himself wiser than his master, and attempted to complete the natural system. "How I laughed when I saw it!" exclaimed Linné.

He compared the natural system to the squaring of the circle, and this comparison is perhaps even more correct than Linné realized, because, as Goethe said, "Natural system is a contradictory term, Nature has no system." Every system introduces boundaries where in Nature there are none, every system emphasizes some features as important and neglects others as insignificant, whereas Nature hardly knows such differences. Consequently every system is artificial.

* * *

But we have now to deal with the consequences of Linné's bastardization experiments for his theoretical views. We have to deal with what is perhaps the most interesting of his writings, the dissertation *Fundamentum Fructificationis*, published in 1762, soon after the prize essay. Graberg signed it as nominal author.

In consideration of its fundamental importance I shall quote this paper extensively.

"For a long time past", says Linné (and this is one of the passages where the pupil suddenly appears to be miraculously transfigured into the Master), "I have nourished a suspicion which, however, I do not dare to put out as indubitable truth, but only offer as an hypothesis—namely, the idea that *all the species of the same genus formed only one species originally* and were later multiplied by hybridization, all related plants coming from the same mother while divers fathers made different species of them."

The autobiography mentioned above states: "The *Fundamentum Fructificationis* everyone had spoken of, but nobody had understood. Linné's argument was that of all the genera of vegetables there had

originally been created but one specimen, that this had accidentally been impregnated by others, whence the internal parts acquired a resemblance to the mother and the external parts to the father, as always happens in a hybrid progeny: that in this way so many species were produced, and that consequently those which agree in their fructification are of one family and substance and of like nature and properties—in other words a natural genus."*

In *Fundamentum Fructificationis* Linné contemplates Compositae from different continents and finds them agreeing with each other to such an extent that their common origin from one single species seems entirely clear. Some species of other families hardly admit of boundaries between them, and this again seems to prove their common origin.

"It would be worth while for a botanist to castrate the flowers of *Digitalis purpurea* and fecundate its stigmata with the anthers of *Verbascum Thapsi.* I should be very much mistaken if the result was not *Digitalis Thapsi.* Such experiments will have to be made on a large scale before this hypothesis can be converted into an axiom. But then it will supply a key to the natural genera, and it will be possible safely to conclude that the species are the daughters of time."

"To see in many rich genera of plants many daughters of the same mother and of divers fathers—that may well be a theory which every expert botanist might think he cannot tolerate", Linné confesses. He goes on: "Whether those species have been created by the hands of the Almighty Creator in the very beginning, or by *Nature, the Executrix of the Creator*, in the course of time, will not be so easily demonstrated even when a great number of new and manifold experiments have been performed."

From the comparison of plant families, Linné had deduced his famous sentence: "Natura non facit saltus." But if all plants were separate creations, their resemblances were an unsolvable puzzle. Now the entire vegetable kingdom appeared to him as a product of general intermixture. In the beginning the Almighty Creator had made *only one vegetable of every natural order*. These differed among each other in habit and fructification. But then, He fecundated them naturally so that the offspring formed as many genera as there were different fathers. Then, after so many genera had arisen as there were individuals before, the various genera fecundated each other in the course of time, until as many species had been produced as exist to-day. If some genera were multiplied into very numerous species, whereas others were not, that might have been due to better conditions for fecundation. The species again were impregnated by related ones and produced those varieties which cannot be explained simply as products of soil and climate.

* * *

That was a highly satisfactory explanation of the sentence "Natura non facit saltus". The plants resemble each other, because they are actually "congeneres", especially those of the same genus, coming all from the same mother. The terms "natural genus" and "natural family" which Linné had always used, seemed supremely justified if this hypothesis proved to be correct.

"From this theory it becomes clear why related plants agree in their structure, properties, virtues—namely, because they come from the same stock—a fact which could not be explained otherwise." It is only a working hypothesis, Linné comments he cannot prove it yet and therefore does not obtrude it to anyone, but without such a concept a clear and natural classification cannot be achieved.

Linné assumes "that owing to the very

* The idea that the "inner" parts always resemble the mother and the external parts the father (which in plants means organs of fruiting come from the mother), has in some other place assumed an interesting form. "Sons", Linné states, "often have the mind and soul of their mothers and daughters the countenance and outward appearance of the father."

old age of this world probably all the species which could be easily produced have been produced a long time ago, yet *I would not dare to swear that there are not more plants in Europe to-day than* 140 *years ago, when Bauhin published his catalogue*."

A footnote comments: "Nobody will deny that *Gentiana quadrifolia* has arisen from *Gentiana perfoliata*, since their organs of fruiting agree as closely as they differ from all others. But with regard to their leaves they constitute two entirely different species which no mortal man would combine into one."

When Edward L. Greene made an excursion through Linné's *Species Plantarum* in search of some descriptions of plants, he found more notes of the same type spread all over the book. Up till then he had known Linné only as the believer in species being as old as the world, and this discovery startled him into reading a paper under the heading "Linné as an Evolutionist" to the Washington Academy of Science.

* * *

What Greene found in the book were laconic queries referring to *Thalistrum lucidum*, such as "Is this plant sufficiently distinct from *T. flavum*? It seems to be a daughter of time." Or referring to *Achillea Ptarmica alpina* which is found only in the Siberian mountains: "Can the locality have formed this plant from the preceding?" Or referring to *Hibiscus Virginicus*: "May not the Venetian species have sprung from the Virginian?" Or to *Beta vulgaris*: "Possibly born from *Beta maritima* in some foreign country." And so forth.

Some of these cases may perhaps fit into Linné's theory of hybrids, as he was always on the look-out for the fathers and mothers of such offspring, but in some cases he emphasizes the possible influence of surroundings. The plants compared in this manner are frequently living on different continents, and Greene considers this circumstance particularly puzzling. It does not seem so to me, in view of Linné's ideas about the easy distribution of plants all over the world. It is beyond my competence to judge whether Linné would have deprived the plants in question of their rank as species in their own right and classed them as varieties, if he had been able to prove that they were the product of their surroundings.

However that may be, it is certain that he had set his mind upon discovering *the origin of species* and, as the motto prefixed to the first instalment of this article shows, he admonished all botanists to follow his example.

* * *

In the same year as the *Fundamentum Fructificationis*, 1762, another "academic amenity" was published by Linné which he called *Reformatio Botanices*. Here he gives a history of botany and of the new discoveries made up to that time; then follows what Richard Wettstein has described as a *Botanical Testament*. This begins with the words: "Many tasks are reserved for future botanists of which present botanists have hardly tasted with the tip of their tongues..." Twenty subjects are enumerated including one which interests us particularly (no. 13): "*to find out the ancestors of species and hybrids—a work for many centuries*."

Thirty years before, in his *Critica Botanica*, Linné had proclaimed: "If botanists should ever reach the point where they can bring all plants under their genera with absolute certainty and can assign essential names to all species, there is nothing further to be done." Anyone who is desirous to get a lively picture of this great naturalist's mental development should compare this first primitive notion about the aims of botany with the twenty articles set forth in the *Botanical Testament* as the business of future botanists.

It is a puzzle why Linné, in his old age, although bent upon ascertaining the origin of species, still kept in all later editions of

Philosophia Botanica the much-quoted dictum, "Species tot numeranus quot diversae formae in principio sunt creatae", and all the other aphorisms connected with it. In *Systema Naturae* some sentences of the same tenor disappeared from the last editions. Why not from *Philosophia Botanica*?

It is sometimes said that in his official text-books Linné, like many other professors, was careful not to introduce unproved hypotheses. But after all his speculations about hybrids constituting the entire realm of vegetables, could he still consider his aphorism 157 a proved fact? I can only imagine one explanation for his behaviour. The whole book was in its greater part a series of definitions of botanical terms. But as his definition of the species was exclusively based on its constancy, what other definition could he give after sacrificing the idea that the species were eternal and unchangeable? None. So it was rather the expression of his perplexity than of his scientific conviction that he maintained these sentences which have proved so very obnoxious to his reputation.

* * *

Nordenskjoeld, in his *History of Biology*, remarks that "the opponents of the theory of evolution quoted Linné as their chief authority, not only on scientific grounds but also from motives which lay far removed from all scientific causes. His primitive Christian piety was thrust into the breach by religious and social conservatism against the 'unbelief' of the new biology. It was inconceivable that in such circumstances Linné and his works should be judged impartially."

No study is so instructive, so amusing and makes us so proof against the slogans and scientific fashions of our period as the study of the history of science. What can be more enlightening than to know that this same Linné who was put forward against the Darwinists as the champion of primitive Christian faith, was in his lifetime variously accused of heresy and blasphemy? Thus, for example, when he published his *Sexual System*, J. G. Siegesbeck is reported to have denounced it as blasphemous and to have written: "Who will believe that God has introduced such harlotry into the vegetable kingdom for the purpose of propagation?"

When Linné began to study monkey brains, in order to examine the degree of their similarity to human brains, the work caused a scandal, and he left it. In a letter to Gmelin on 14 February 1747, he wrote: "People are scandalized because I included Man into the Anthropomorphae. But Man knows himself. Let us omit the word. I don't mind what name we use, but I demand of you and of the whole world that you show me a generic character—I mean a difference as required by the rules of science —by which to distinguish Man and Ape. I myself most assuredly know of none, and I wish someone were able to set forth even one. But if I had called man a monkey or vice versa, I should have had all the theologians against me. Though indeed, according to the professional rules, I possibly ought to have done it."

Linné had placed man and apes into the same genus, and distinguished man only by calling him *Homo sapiens* with the motto "Nosce te ipsum". That seems to have been the only difference he could detect between the two.

If only the Darwinists had known! And how is it possible that they did not? Darwinists, by the way, would have found plenty of encouragement in Linné's papers, had they thought of studying them. Thus, for example, in the very interesting treatises on *Politia et Oeconomia Naturae*, Linné speaks of the "bellum omnia inter omnes", of mimicry and of sex competition. "We find no species of animals exempt of the stings of love... Birds look more beautiful during rutting time and warble all day long through lasciviousness. Small birds labour to outsing one another and cocks to outcrow..."

In his *Autobiography* Linné confesses that he would willingly have believed the

earth to be older than the Chinese assert, had the Scriptures allowed him. He had never seen "rudera diluvii universalis", but "successiva temporis". He had never been able to get through "rudera aevi" to "terra primogenita".

That means: "On the grounds of my studies I have no reason to believe in a universal flood, but I do believe in several successive floods. I never saw primitive earth, but only layer after layer of successive epochs. Based on these observations I can hardly believe the earth to be so young as the Holy Scriptures assert."

* * *

Almquist says that no religious belief was connected with the notion of the primary creation of all species, that those who saw new species spring up every day in their gardens were probably no less religious people. That seems very true. Nor need we suspect the piety of those who believed in the *Transmutatio frumentorum*, according to which "in an impoverished soil wheat can be changed into rye, rye into barley, barley into darnel, darnel into brome grass, and brome grass into oats", while a rich soil can produce the inverse transmutation. When Linné opposed this doctrine, he certainly did not do so on religious grounds, he simply asserted that a careful observer could not ascertain such changes. And because his own early observations seemed to prove that "the same comes always from the same", he formed the idea that the species had been created in the beginning. Later, in the triumphant epoch of rising Darwinism, the mental fashion again favoured such wild ideas concerning transmutation, and we are told that even in the second half of the nineteenth century a scientist seriously attempted to transform doves into hawks by feeding them with meat.

This is amusing when we remember that a hundred years before Linné had written: "We do not believe that the peaceful dove can give birth to ferocious eagles." Linné's argument that because plants are reproduced by seeds, the same must infallibly be reproduced over and over again, was certainly a short-circuit. He did not bother about the way in which the traits of the parents come into the seed. Unconsciously, he denied the transmittability of acquired characters, unconsciously he anticipated the theory of the "Continuity of the Germ Plasma" (Weismann).

Yet it is hard to see what religion should have to do with all these things. "We must consider it an axiom", says Linné, "that there is no spontaneous generation, that every living thing and every plant comes from an ovum or seed." If faith instead of observation had inspired his doctrines, we should think that the assumption of spontaneous generation would have seemed more natural. And why should the Almighty Creator not let new plants spring from the earth every day at His pleasure? This would seem logical. But, unfortunately, we must admit that *Homo sapiens* is not always guided by pure logic. And so we are told that the Archiater Zimmermann in Germany wrote, in 1755: "Herr Linné has, probably without any bad intention, given much undesirable material to the deniers of God. It is his opinion that every day new plants arise." Linné coined two very lucky phrases which, in my opinion, would have been excellently fitted to do away, once and for all, with those fanatic and ridiculous fights between scientists and the clergy, which were based on the same fallacious assumption on both sides. Scientists believed that with some new discovery in physics or biology they could disprove the existence of God, and theologians on their part shared this belief and therefore felt coerced to attack every new doctrine.

The two phrases to which I refer, are: "We can more easily deduce the laws which God has embodied in Nature from experience than from preconceived opinions." And the other: "Nature, the Executrix of God..." By these turns of expression Linné has solved for himself the conflict

between his religious faith and his scientific conscience.

In one place he wrote: "God created one vegetable of every natural genus and then *ordered them* to fecundate each other." Of course, any modern text-book might as well be written in this style. God orders hydrogen and oxygen to form water. A religious Darwinist might say: "God arranged for the development of Man from lower animals by the means of natural selection." No mortal being would ever be able to prove or disprove such statements. And this is the reason why Kant insisted on keeping scientific language free from God. Not because he himself was irreligious, which he was not, but because science should confine itself to statements which have some chance of being tested.

If it were generally accepted as an undemonstrable axiom that Nature is the Executrix of God, this would give full freedom to keep God aside from scientific discussions while at the same time admiring Him in His works. And this is exactly what Kant did.

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Mr Tompkins in Wonderland

By Professor G. GAMOW

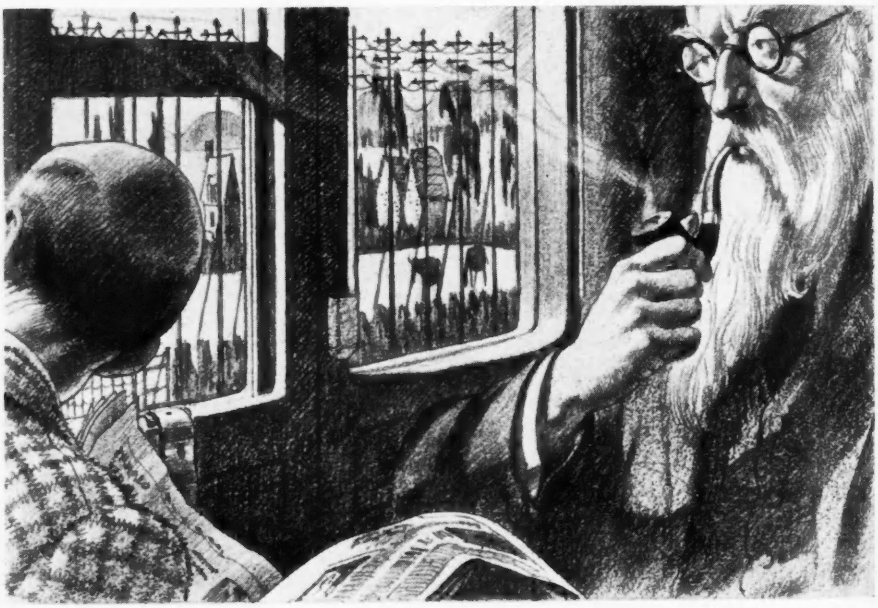
Dream V: Mr Tompkins Takes a Holiday*

MR TOMPKINS was very amused about his adventures in the relativistic city, but was very sorry that the Professor had not been with him to give any explanation of the strange things he had observed: the mystery of how the railway brakeman had been able to prevent the passengers from getting old worried him especially. Many a night he went to bed with the hope that he would see this interesting city again, but the dreams were rare and mostly unpleasant; last time it was the manager of the bank who was firing him for the uncertainty he introduced into the bank accounts...so now he decided that he had better take a holiday, and go for a week somewhere to the sea. Thus he found himself sitting in a compartment of a train and watching through the window the grey roofs of the city suburb gradually giving place to the green meadows

* The conditions here are the same as in Dream III: the velocity of light is about 10 miles per hour, the other world constants are as usual.

of the countryside. He picked up a newspaper and tried to interest himself in the French-Italian conflict. But it all seemed to be so dull, and the railway carriage rocked him so pleasantly....

When he lowered the paper and looked out of the window again the landscape had changed considerably. The telegraph poles were so close to each other that they looked like a hedge, and the trees had extremely narrow crowns and were like Italian cypresses. Opposite to him sat his old friend the Professor, looking through the window with great interest. He had probably got in while Mr Tompkins was busy with his newspaper.



"*...were so close to each other that they looked like a hedge.*"

"We are in the land of relativity", said Mr Tompkins, "aren't we?"

"Oh!" exclaimed the Professor, "you know so much already! Where did you learn it from?"

"I have already been here once, but did not have the pleasure of your company then."

"So you are probably going to be my guide this time", the old man said.

"I should say not", retorted Mr Tompkins. "I saw a lot of unusual things, but the local people to whom I spoke could not understand what my trouble was at all."

"Naturally enough", said the Professor. "They are born in this world and

consider all the phenomena happening around them as self-evident. But I imagine they would be quite surprised if they happened to get into the world in which you used to live. It would look so remarkable to them."

"May I ask you a question?" said Mr Tompkins. "Last time I was here, I met a brakeman from the railway who insisted that owing to the fact that the train stops and starts again the passengers grow old less quickly than the people in the city. Is this magic, or is it also consistent with modern science?"

"There is never any excuse for putting forward magic as an explanation", said the Professor. "This follows directly from the laws of physics. It was shown by Einstein, on the basis of his analysis of new (or should I say as old-as-the-world but newly discovered) notions of space and time, that all physical processes slow down when the system in which they are taking place is changing its velocity. In our world the effect is almost unobservably small, but here, owing to the small velocity of light, they are usually very essential. If, for example, you tried to boil an egg here, and, instead of letting the saucepan stand quietly on the stove, moved it to and fro, constantly changing its velocity, it would take you not five but perhaps six minutes to boil it properly. Also in the human body all processes slow down, if the person is sitting (for example) in a rocking chair or in a train which changes its speed; we live more slowly under such conditions. As, however, all processes slow down to the same extent, physicists prefer to say that *in an ununiformly moving system time flows more slowly*."

"But do scientists actually observe such phenomena in our world at home?"

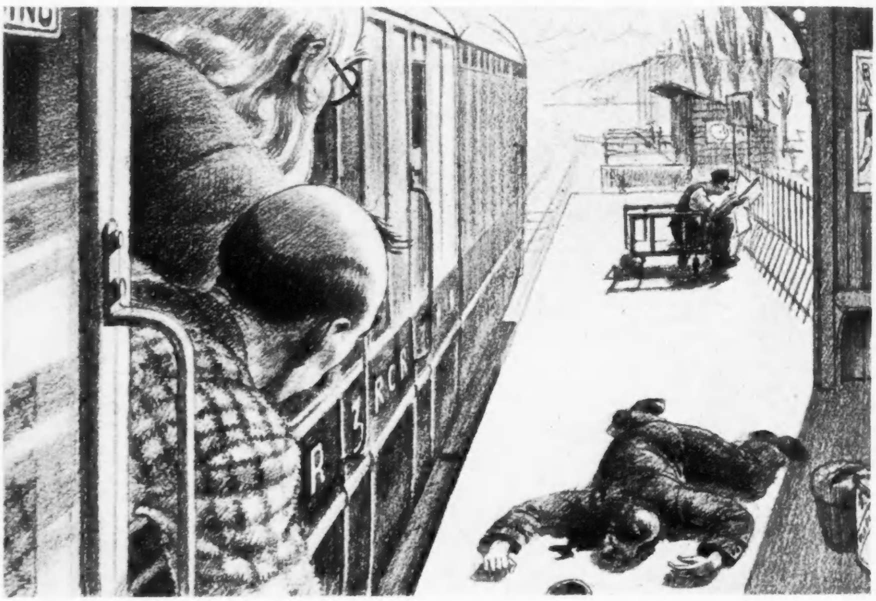
"They do, but it requires considerable skill. It is technically very difficult to get the necessary accelerations, but the conditions existing in an ununiformly moving system are analogous, or should I say identical, to the result of the action of a very large force of gravity. You may have noticed that when you are in an elevator which is rapidly accelerated upwards it seems to you that you have grown heavier; on the contrary, if the elevator starts downwards (you realize it best when the rope breaks) you feel as though you were losing weight. The explanation is that the gravitational field created by acceleration is added to or subtracted from the gravity of the earth. Well, the gravity on the sun is much larger than on the surface of the earth and all processes there should be therefore slightly slowed down. Astronomers do observe this."

"But they cannot go to the sun to observe it?"

"That did not require to be said. They observe the light coming to us from the sun. This light is emitted by the vibration of different atoms in the solar atmosphere. If all processes go slower there, the period of atomic vibrations also decreases, and comparing it with light emitted by terrestrial sources one can see the difference. Do you know, by the way"—the Professor interrupted himself—"what the name of this little station is that we are now passing?"

The train was rolling along the platform of a little countryside station which was quite empty except for the station master and a young porter sitting on a luggage

trolley and reading a newspaper. Suddenly the station master threw his hands into the air and fell down on his face. Mr Tompkins did not hear the sound of shooting which was probably lost in the noise of the train, but the pool of blood forming round the body of the station master left no doubt. The Professor rapidly pulled the emergency brake and the train stopped with a jerk. When they got out of the carriage the young porter was running towards the body, and a country policeman was approaching.



The pool of blood forming round the body left no doubt

"Shot through the heart", said the policeman after inspecting the body, and, putting a heavy hand on the porter's shoulder, he went on: "I am arresting you for the murder of the station master."

"I didn't kill him", exclaimed the unfortunate porter. "I was reading a newspaper when I heard the shot. These gentlemen from the train have probably seen all and can testify that I am innocent."

"Yes", said Mr Tompkins, "I saw with my own eyes that this man was reading his paper when the station master was shot. I can swear it on the Bible."

"But you saw him reading a newspaper when you were in the moving train", said the policeman, taking an authoritative tone, "and that is no evidence at all. As seen from the platform the man could have been shooting at the very same moment.

Don't you know that simultaneousness depends on the system from which you observe it? Follow me", he said, turning to the porter.

"Excuse me, constable", interrupted the Professor, "but you are absolutely wrong, and I do not think that at headquarters they will like your ignorance. It is true, of course, that the notion of simultaneousness is highly relative in your country. It is also true that two events in different places could be simultaneous or not, depending on the motion of the observer. But, even in your country, no observer could see the consequence before the cause. You have never received a telegram before it was sent, have you? or got drunk before opening the bottle? As I understand you, you suppose that owing to the motion of the train the shooting was seen by us much *later* than its effect and, as we got out of the train immediately we saw the station master fall, we still had not seen the shooting itself. I know that in the police force you are taught to believe only what is written in your instructions, but look into them and probably you will find something about it."

The Professor's tone made quite an impression on the policeman and, pulling out his pocket book of instructions, he started to read it slowly through. Soon a smile of embarrassment spread out across his big, red face.

"Here it is", said he, "section 37, subsection 12, point *e*: 'As a perfect alibi there should be recognized any authoritative proof, from any moving system whatsoever, that at the moment of the crime or within a time interval $\pm cd$ (c being natural speed limit and d the distance from the place of the crime) the suspect was seen in another place.'"

"You are free, my good man", he said to the porter, and then, turning to the Professor: "Thank you very much, Sir, for saving me from trouble with headquarters. I am new to the force and not yet accustomed to all these rules. But I must report the murder anyway", and he went to the telephone box. A minute later he was shouting across the platform "All is in order now! They caught the real murderer when he was running away from the station. Thanks a lot, once more!"

"I may be very stupid", said Mr Tompkins, when the train started again, "but what is all this business about simultaneousness? Has it really no meaning in this country?"

"It has", was the answer, "but only to a certain extent; otherwise I should not have been able to help the porter at all. You see, the existence of a natural speed limit for the motion of any body or the propagation of any signal, makes simultaneousness in our ordinary sense of the word lose its meaning. You probably will see it more easily this way. Suppose you have a friend living in a far-away town, with whom you correspond by mail, train mail being the fastest means of communication. Suppose now that something happens to you on Sunday and you learn that the same thing can happen to your friend. It is clear that you cannot let him know about it before Wednesday. On the other hand, if he knows in advance about the thing that was going to happen to you, the last date to let you know about it

would be to write on the previous Thursday. Thus for six days, from Thursday to next Wednesday, your friend was not able either to influence your fate on Sunday or to learn about it. From the point of view of causality he was, so to speak, excommunicated from you for six days."

"What about a telegram?" suggested Mr Tompkins.

"Well, I accepted that the velocity of the mail train was the maximum possible velocity, which is about correct in this country. At home the velocity of light is the maximum velocity and you cannot send a signal faster than by radio."

"But still", said Mr Tompkins, "even if the mail train velocity could not be surpassed, what has it to do with simultaneousness? My friend and myself would still have our Sunday dinners simultaneously, wouldn't we?"

"No, this proposition would not have any sense then; one observer would agree to it, but there would be others, making their observations from different trains, who would insist that you eat your Sunday dinner at the same time as your friend has his Friday breakfast or Tuesday lunch. But in no way could anybody observe you and your friend simultaneously having meals more than three days apart, because the menus could be then connected causally."

"But how can all this happen?" exclaimed Mr Tompkins unbelievingly.

"In a very simple way, as you might have noticed from my lectures. The upper limit of velocity must remain the same as observed from different moving systems. If we accept this we should conclude that..."

As the Professor spoke these last words Mr Tompkins noticed some very strange changes in his face. His grey hair changed into a lovely golden colour, his eyebrows suddenly became thin and nicely arched, and his eyelashes grew longer. Finally, his long beard also disappeared and Mr Tompkins was looking into the face of a pretty young girl who had got in at the last station. She was inspecting him with surprise and a hidden smile. Mr Tompkins rapidly picked up his newspaper from the floor and hid behind it for the rest of the journey. He was a very shy man, and very much afraid of women.

Notes of the Month

A New Type of Atom-Splitting

FOR many years now it has been possible to break up the "nucleus" or innermost core of the atom and so virtually transmute one atom into another. The nucleus, since it can be split, is not considered as a simple particle but as made up of two types of units, protons and neutrons. In all the observed cases (up to a few weeks ago, that is) where one nucleus has been transmuted into another, at *most* four of the elementary units (two protons and two neutrons) have been knocked out of the original nucleus in a transmutation process. So accustomed in fact had physicists become to this rule, that until a great deal of evidence had been accumulated which cast doubt upon its validity in certain cases, no thorough attempt was made to look for bigger groups of particles that might be knocked out of the nucleus.

Recently, Hahn and his collaborators in studying the transmutation of the element uranium by neutrons came to the conclusion that there was formed in this process an element whose chemical properties were identical with those of the element barium. Barium, however, has a much smaller nucleus than uranium, and in order that the nucleus of barium be formed from the splitting up of the uranium nucleus, this latter must lose a piece (a krypton nucleus) containing between eighty and ninety elementary particles (the uranium nucleus contains about 230 and the barium nucleus about 140 elementary particles (protons and neutrons)). This is a much larger piece of the nucleus than has ever previously been detached in an atomic transmutation. In this new process, instead of a small piece of the nucleus being detached, the uranium nucleus is split into two parts of about the same size.

Uranium itself is not a stable atom; its nucleus, like that of radium, emits nuclear particles (in groups of four), and so is naturally transformed into a new element. This product in turn is unstable and emits a particle and is transformed into a new unstable product. This process is repeated until all the excess energy is dissipated in a series of small successive steps and finally stable atoms of lead are left.

If the uranium nucleus were to split up in one single jump into a barium nucleus and a krypton nucleus the energy release expected is enormous, about twenty or thirty times that normally associated with a nuclear disintegration. In fact, although in such a process the products would be very big groups of elementary particles, the energy emitted in the process is so large that these massive particles should possess very high velocities. It is this combination of a large mass with a high velocity which has made the detection of such a process very easily observable. It has so far been definitely established that when both uranium and thorium are irradiated with neutrons, disintegrations of this new type take place, the nuclei in both cases being

split up into two parts of about the same size. It is not yet perfectly definite into what two elements the uranium (or thorium) nucleus breaks up or even whether it always splits up into the same pair of atomic nuclei. What has definitely been established is that uranium and thorium (both in themselves unstable elements) can be split up by neutrons into two large, very energetic and approximately equal pieces.

Heavy stable elements like lead, gold, bismuth, etc., appear not to possess enough energy for this process to occur sufficiently often to detect, if it occurs at all. One surprising feature of the discovery is that the small extra energy supplied by the neutron is sufficient to cause the uranium to split up, whereas by itself, despite its large excess of energy, it can disintegrate only in small successive steps. Experiments are now being carried on in many laboratories of the world in order to obtain further and more precise information of this latest type of atomic transmutation.

S. D.

(*Hahn and Strassmann, Berlin*)

Invisible Glass

KATHERINE B. BLODGETT reports from the Research Laboratory of the General Electric Company in New York State that she has made definite progress in her work concerned with extinguishing the reflection of light from glass. A film is made coating the glass surface; it is prepared in such a way that the light reflected from the outer surface is equal in intensity and opposite in phase to the ray reflected from the glass-film surface. Under these conditions no light is reflected. Built-up films of the soaps of fatty acids have provided a substance of the value of refractive index which is required. The films are unfortunately soft and can be wiped from the glass with a cloth. Using cadmium arachidate films Miss Blodgett was able to increase the transmission of light which is 92 % for clean glass to 99·2 % for film-coated glass plate.

H. L.

(*Blodgett, Schenectady, U.S.A.*)

Multimolecular Films

THE spreading of films only one molecule thick of various substances upon water has been a valuable scientific technique for twenty years.

The above announcement that a glass plate can be rendered invisible by coating it with suitable films illustrates the new *multilayer* technique devised by Langmuir and Blodgett. They have shown that under certain conditions a *monomolecular* film spread on water can be transferred directly to a metal or glass surface. The plate is dipped in and out of the water and the film pushed forward by another oil film (the so-called "piston oil") from which it is separated by a floating

thread barrier. By repetition of this process *multilayers* can be built up on the solid and films many hundreds of molecules thick have been obtained.

Using this technique multimolecular films of fatty acids, soaps, esters, sterols and proteins can be prepared. The films exhibit beautiful interference effects, the colour varying with the number of layers present, and layers only a few molecules thick can be detected by the eye. The optical properties have been studied in detail and the dimensions of the molecules evaluated. The length and degree of orientation so obtained are in remarkably good agreement with those already found by other methods. Recent work has shown that the multilayers have an oriented microcrystalline structure; indeed, the technique affords a very convenient method for crystallizing minute amounts of organic compounds. L. L.

(*Langmuir and Blodgett*, *Schenectady*, *U.S.A.*)

The Action of Strychnine

WHEN certain nerves (for instance, those serving most voluntary muscles) are stimulated, a substance is set free at their ends. This substance is composed of choline and acetic acid. It is called "acetylcholine" and is probably the immediate transmitter of nervous impulses to the organ they supply. A nervous stimulus is of extremely short duration, and if acetylcholine is the true transmitter substance it has to be supposed that it can be destroyed nearly as quickly as it is formed. There exists, in fact, a mechanism in the tissues which splits acetylcholine into acetic acid and choline, both of which are ineffective by themselves. This factor is an enzyme called acetylcholine esterase. It can be obtained from living tissues in cell-free extracts. These solutions separate the added transmitter into its two components.

Dr Nachmansohn, working at the Laboratoire de physiologie générale de la Sorbonne, has just been able to show that the addition of strychnine to highly purified solutions of acetylcholine esterase decreased its splitting power towards the added transmitter substance. The action of strychnine in the living body may therefore be due to excess of acetylcholine, which is not sufficiently removed and continues therefore to stimulate nervous centres and muscles. In small therapeutical amounts strychnine produces excitability of the nervous system; the eyesight becomes sharper, respiration and blood pressure increase. Larger doses of the drug result in convulsions; muscles cramp and respond to most insignificant impulses with violent contractions. H. L.

(*Nachmansohn*, *Paris*)

Diagnosing Diphtheria

THE rapidity with which diphtheria progresses and endangers the life of the patient, and the importance of its early treatment, make it essential that it should be diagnosed as quickly as possible. The usual method of doing this is to take a swab

of the patient's throat and grow the bacteria which are present on a special medium. After some twenty-four hours, it is possible to obtain a sufficient number of organisms to be able to identify them. But frequently the doctor cannot wait as long as this and must decide, on the results of his own examination of the patient, whether to inject serum. The diagnosis is not always easy, for early diphtheria often resembles an ordinary sore throat or tonsilitis. Dr Mangullo of Buenos Ayres has discovered a new and extremely simple method of testing for the presence of the diphtheria bacillus. A swab is dipped into a solution of a certain salt, potassium tellurite, and then is made to touch the suspected grey membrane in the patient's throat. If organisms of diphtheria are present, the swab turns black within ten minutes. In only 2 cases out of 75 the test was found to fail, so that, although the taking of the usual growth culture must not be neglected, in the vast majority of cases the diagnosis is established in a few minutes and treatment can be decided at once. J. Y.

(*Mangullo, Buenos Ayres*)

New Bones for Old

UNDER this title, Professor Hey Groves, the well-known English surgeon, who has for many years made a special study of bone fractures and their treatment, has recently described some of the new methods of bone grafting. A portion of bone may die because of some infection, or because, after a fracture, the blood vessels nourishing the broken fragments have been damaged. The most usual method of restoring the function of the damaged part by a bone graft is to use a portion of living bone from the patient himself, taken from some part, such as the shin, which can easily spare it. This necessarily involves the double operation of removing the required piece of bone and of replacing it in the desired situation.

It has, however, been shown that quite good results may be obtained by using dead bone. This has several advantages. In the first place, the time needed for the operation is considerably shortened since the graft can be cut to the correct size and shape before the operation begins. Moreover, human bones are not essential. Animal bones can be used so that much larger grafts can be made than could possibly be obtained from the skeleton of the patient. Professor Hey Groves has himself used a piece of ivory from a walrus tooth, a beef bone and a stag's antler, all with extremely good results. The beef bone was used to repair the broken humerus in the arm of a boy. The arm not only grew normally, but the boy later became a very tall athlete and actually won the weight throwing competition in the inter-Varsity sports.

But these bones are never so good as the living bone. An interesting attempt has quite recently been made to combine the advantages of living bone with those of previously shaped animal bone. This is done by taking a piece of animal bone, shaping it as necessary and then implanting it against a healthy bone of the patient. After a few months, the animal bone is found to be covered with living tissue.

This resuscitated bone, together with the living tissue surrounding it, is then used for the graft. In the few cases where it has so far been tried, the results are very satisfactory.

J. Y.

(*Hey Groves, England*)

Mapping Temperatures by Pyrometric Paints

For many years substances such as mercuric iodide which change colour on heating have been little more than mere curiosities. Now technologists have found a practical use for them which offers great promise for the future. They are being used to indicate temperatures in industrial plants, and some of the results obtained have been interesting. It has been known for a long time, for instance, that the double salt of cupric and mercuric iodide is *scarlet red* below 60° C., changes to *chocolate brown* between 65 and 75° C., and *browny black* around 110° C. Using this substance it was therefore possible to indicate when a piece of apparatus had reached 60 and 110° C. It was also found that if such materials were made up into a paint with some such base as oil varnish or lacquer that they were even more sensitive to heat. For instance, using a mixture of 1 part of cupric iodide and 2 parts of mercuric iodide in a lacquer base it was possible to create a colour chart, each colour on which matched a particular temperature. Thus at 60° C. the paint was light brown: as the temperature was successively raised to 65, 70, 75, 95, 105–110° C. the paint was found to turn successively chestnut brown, light chocolate, chocolate brown, browny black and black. Such paints were considered accurate within 5° C., which is sufficient for certain commercial purposes. Also, if the temperature was not raised above 150° C. this pyrometric paint was still usable when the temperature was lowered, as the colour effect is reversible.

A more recent and satisfactory development has been the use of special "bronzes" known in Germany as "Patentbronzes". These substances are composed of an aluminium powder which is rendered mordant to dyes by tannin, then heated with oxalic acid and finally tinted with suitable heat-sensitive aniline dyes. These paints are rather more sensitive, and more accurate in use. For instance, one of these bronzes has a well-defined colour change from green to yellow at 60° C. (This paint is also "reversible".)

All the above paints give a non-persistent colour change. Paints giving a permanent change can be made by the incorporation of mercuric sulphate, mercuric iodide, lead carbonate or cadmium carbonate in a suitable base. In Germany a great deal of research has been carried out upon these pyrometric paints in the Oppau laboratories of the I.G. Farbenindustrie A.-G. Paints known under the trade name of "Thermocolor" have been produced using metal salts that change their colour on the loss of water, carbon dioxide and ammonia from their composition on heating. Actually, *out of* 300 *trial paints tested, only* 12 *were found to be of practical value*. But with their use it has been possible to chart very clearly the

various temperatures maintained in such a piece of apparatus as an air-cooled motor engine. Most of these "Thermocolors" have very definite colour changes: for instance, No. 4 changes from red to blue at 140° C., with a transition in colour as sharp as that of neutral litmus paper placed into strong alkali solution; No. 6 has a sharp colour change from green to brown. One of the most effective uses has been in charting the various temperatures of individual regions of an air-cooled motor engine. After heating the motor had a bizarre coat of many colours! W. E. D.

(*Industrial research workers, Oppau, Germany*)

Evidence of Early Cave Man in Oregon, U.S.A.

THE date of the appearance of early man in America is still unknown. No remains older than a few thousand years have yet been found. A fresh source of evidence is afforded by cave exploration in south central Oregon. Since 1934 Dr L. S. Crossman of the University of Oregon has been engaged in the exploration of caves eroded by the action of glacial lake waters in the Ice Age. These lakes were formed by the damming of valleys by ice, and as the ice receded and the lakes were drained, the falling level of the waters left the caves high and dry. Some of them are now as much as two hundred feet above the present level of the valley floor. Evidences of human occupation extending over a prolonged period have been found in the cave deposits. In some instances the débris of occupation extends to a depth of nine feet. Basketry and pottery point to the presence of "recent" man, though of archaic culture. A preliminary report recently issued by the Carnegie Institution records the interesting discovery of human skeletal remains which, it is believed, may belong to the period at the close of the Ice Age, when the waters of the lake had begun to fall. This cave in which these remains were found is situated in the Catlow Valley. They were embedded six inches deep in a deposit of gravel which lay seven feet below the surface of the deposits in the cave. The unscratched condition of the bones suggests that the body was deposited here by wave action when still whole and partially covered by flesh. If, as Dr Crossman believes, deposition took place when the level of the lake had fallen to a point at which the cave was invaded only by storm waters, this would place the date of the human remains at about 15,000 years ago. In another cave in the region evidence of the earliest human occupation was found beneath a layer of pumice, to which vulcanologists on comparative evidence assign an antiquity of 10,000 years. E. N. F.

(*L. S. Crossman, Oregon, U.S.A.*)

Our cover picture this month ***is of a full-fed caterpillar of the Privet Hawk Moth*** **(SPHINX *ligustri*),** ***common enough in the southern half of England. One of the handsomest of British caterpillars, and of vivid colouring, it is nevertheless difficult to detect on a privet bush because its colour markings give it a strong resemblance to a spray of leaves twisting away from the eye. The attitude in the photograph is characteristic.***

THE DUCK-BILLED PLATYPUS

"The Platypus is a historical character. It set the anatomists all agog when specimens were first examined in Europe. It seemed illogical, self-contradictory, impossible, yet there it was, an amphibious creature which nests in a burrow, has a duck's beak, a mole's fur, webbed claws, spurs equipped with poison glands; it can growl, while the female of the species lays eggs and suckles her young." (*See* "*Notes of the Month*", *March*, 1939.)

This photograph, sent to us by Mr Edward Samuel of Sydney, is of Australia's only tame Platypus.

Coast Erosion

Contributed by F. W. Ritchie

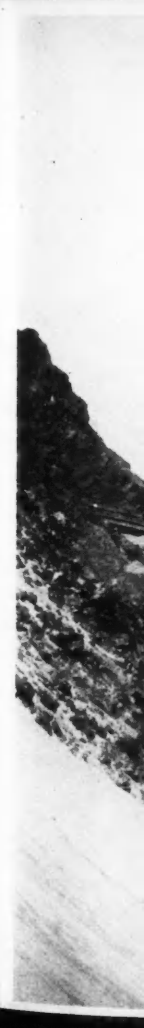
THIRTY years ago, from the east bank AT THE MOUTH OF THE RIVER DEVERON, BY BANFF, to the main coast roadway stretched a green sward large enough for cricket matches to be played on it. To-day, the sea has claimed practically the whole of this field and left scarcely enough safe ground on which to build a bungalow. The dotted line on the right of the photograph above indicates approximately the high water mark 30 years ago. The high water mark of to-day can be seen in the centre of the picture.

Certain local authorities state that the sea has been assisted in its destruction of this part of the coast by the removal of shingle from the beach for road construction. It is roughly estimated that thousands of tons of pebbles have been carted away; this would undoubtedly impair natural protection against the mighty breakers of the Moray Firth. Other authorities maintain that the real cause is the building of a long sea wall at Macduff Harbour half a mile east of this point. This wall, built about 25 years ago, is so situated that when the breakers come from the north-east their fury is deflected by the wall and sent along the coast to break on the wash at the Deveron mouth.

Whatever may be the cause of this wasting of the coast line, something will soon have to be done to protect Banff Bridge seen on the left of this picture. There is also a danger of the main road, leading to the bridge, being badly undermined.

Contributed by Rev. D. W. Darwall

THE two photographs on the right are of an old farm well that has become entirely exposed by the encroachment of the sea at CORTON, SUFFOLK. The well may be seen as one walks along the seashore or along the top of the cliff towards Corton church. The well has been "steined", that is, walled, and the ridges seen in the photograph were "keys" put at the bottom of each stage of "steining" to keep the well in position while further excavation took place. The well is of course quite dry, and is, as far as can be seen, full of sand. There are no traces of the farm to which it once belonged; it has long vanished into the sea. Long ago the neighbouring parish of Newton, including its church, was gradually encroached upon and disappeared.



Easter Island Culture

By R. W. Kidner

(The celebrated Carlos Cruz Montt collection of South American antiquities which recently came under the hammer at Sotheby's was on view for a few days before the sale, and those interested in the ancient culture of Chile, Peru, Bolivia, and Easter Island were able to see some of the most valuable relics of these past civilizations. Below, Mr Kidner describes the culture which inspired the art once flourishing on this lonely rock.)

If you sail out from Tahiti, due east along the tropic of Capricorn, you pass through the Tuamotus, or Low Archipelago, and come at last to the lonely Pitcairn Island; then after 1400 miles of open sea, when all hope of seeing land again has disappeared, a tiny rock appears on the horizon—Easter Island. If you approach from the west, the island's permanent inhabitants are there to greet you, scores of human figures of stone each from ten to thirty feet high, buried up to knees or waist in the green grass slope, all facing out to sea. This picture is well enough known; two of the figures, abducted before the present embargo was enforced, stand outside our British Museum. What is not so generally known, however, is that a complex civilization once flourished on this barren rock.

It is a strange thought. North of Easter Island the nearest land is 4000 miles away; south there is nothing between it and polar ice; to the west, Pitcairn is its nearest neighbour, while to the east the coast of Chile, to whom this scrap of land has belonged since 1888, is 2500 miles away. The island rises sheer from the ocean bed, and visitors have said that lying in the ranch-house at night they can feel the rock sway under the impact of the pounding sea, as a New York skyscraper sways in a high wind. There is no good landing place. The only ship which visits Easter Island regularly is the Chilean gunboat which comes only once a year. This, and any other vessel visiting the island, must steam around it for the duration of its stay; to anchor would be to invite disaster from current and wind.

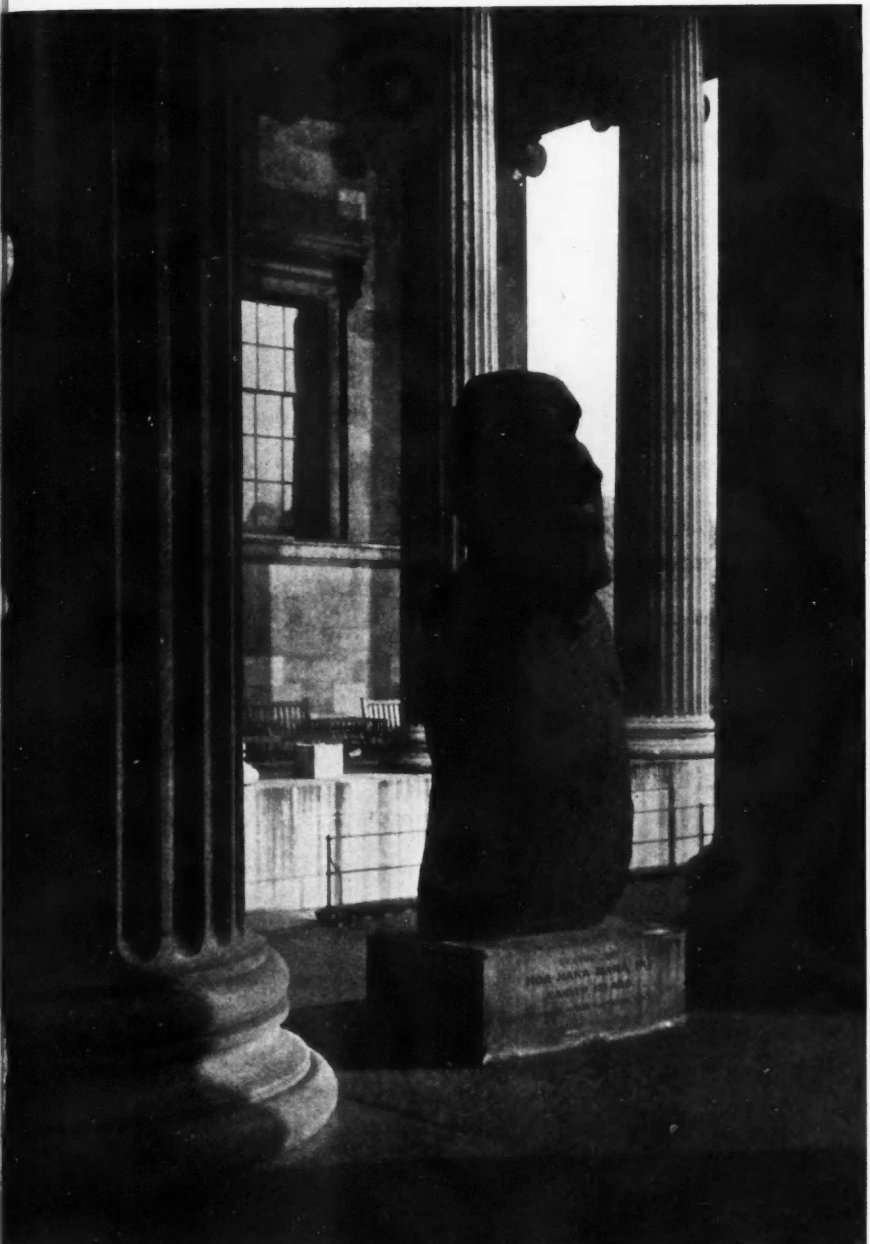
Three questions in particular arise in connexion with Easter Island. Where did the inhabitants come from? How did they support themselves? And how did they contrive, without mechanical aid, to leave the island dotted with huge stone figures?

It is generally considered that a wandering band of warriors from the Tuamotus or Marquesas chanced upon the island and after returning for their womenfolk, set out to colonize it, bringing with them yams, fig seeds, and stone implements. According to legends among the remains of the old Easter Island community in Tahiti, shipped there by Barnier, of Crimean fame, in 1871, the colonizing party was in charge of a chief, and carried several priests, and a number of sacred inscribed tablets.

When the island was first colonized is also a matter of conjecture. When Captain Cook visited it the old civilization was dead. Roggeween reported seeing natives sacrificing to the gods, but this was disproved.

A circumstance which suggests that the colonists must have been led by a man of considerable ability is the existence in the early days of protective tabus. One excellent instance was the cult of the egg-seekers. When in the spring the first sea-bird came over the ocean and circled round the island, hundreds of young men watched. Each man represented one of the elders. The elder whose nimble protegé laid hands on the first egg to be laid on Easter Island was the religious chief for the ensuing year.

For the first five months after this ceremony, no one was allowed to eat sea-birds'



One of the Stone Figures of Easter Island outside the British Museum

eggs. By the time the tabu was lifted the eggs were hatched. So some wise person ensured that sea-birds would always come to the island. If every spring the eggs had been incontinently snatched and eaten the birds would have ceased to come. The bird cult was undoubtedly an instrument of food preservation. Evidence tends to show that during the heroic period of Easter Island culture there was continuous war between clans, and the population was thus kept down to a figure at which the sparse soil of the rock could provide sufficient nourishment; probably less than 5000. From the early nineteenth century there came a succession of plundering ships, pressing recruits for slavery, for working guano.

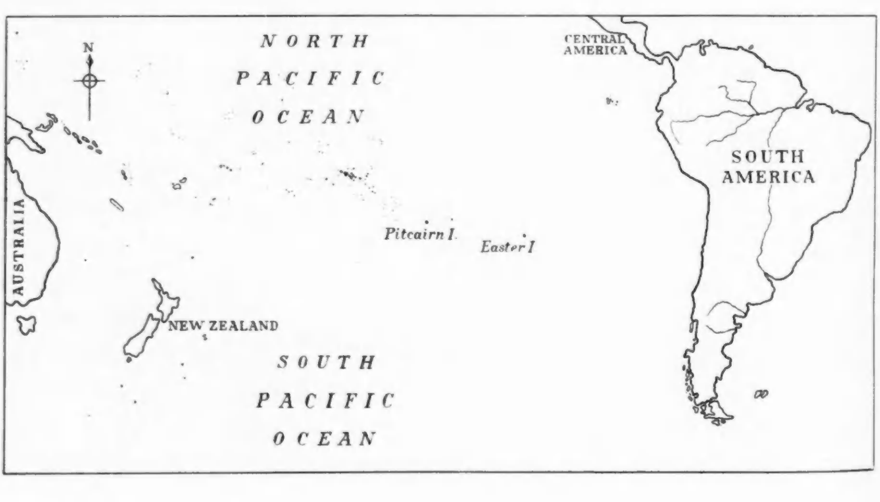
Peruvian raiders on one occasion stole a thousand men from Easter Island. Only fifteen returned, the rest dying of smallpox or tuberculosis in the mines. In 1871 the population was reduced to 175. Now the island supports some few hundreds of sullen-looking men of Polynesian cast, depending for livelihood on the American sheep-ranch on the south side. Of their great past they know nothing.

The witnesses to the splendour of the old culture are hundreds of silent, supercilious, square-faced gods, some wearing abbreviated top-hats. Some formerly sat in rows on walls before they were overthrown in recent times: the majority were sunk in the earth around the base of Raro Kao or Raro Reraku facing out across the sea.

How did the islanders, with no mechanical aid, move these monsters weighing up to forty tons, from the quarries? Thousands of men must have been needed, pulling on ropes, thrusting with staves.

Three facts are worth noting. The figures' hats were quarried from red tufa at Punapau, and not from the same rock as the gods themselves. All the figures were male; and in many the male markings were apparently later defaced.

There are many enigmas on this forty-square-mile outpost; but there is no doubt that at one time, perhaps for less than half a century, a great culture flourished there.



Nutrition and Health

By C. H. March

V. Planning the Menu for the Best Nutrition, and for Slimming

THE preparing of food can be extremely dull, or it can be a most delightful combination of science and art. Attractively served food is an excellent stimulant to gastric secretion and no one can be described as a good cook unless he or she is capable of serving food in this manner. Below is a list of foodstuffs from which you will be able to obtain as varied a menu as you would desire.

1. **Breads**. Wholemeal or white bread, rye bread, wholemeal buns or rolls. If white bread is preferred, a spoonful of a wheat germ preparation should be put on the morning cereal, so that the vitamin B matter will not be lost. It is not just a standard amount of vitamin B that is needed, but a variable amount; the more food eaten, the more vitamin B required.

2. **Cakes**. Those cakes which will supply you with some animal fats in the form of cream should be chosen, for example, cream cakes, cream puffs, cream sponges, waffles with cream.

3. **Biscuits**. If the housekeeping allowance is such that it is difficult to purchase enough energy giving foods, then dry biscuits with their high fat content will give a better value than sweet biscuits. A cheese biscuit or a whole-wheat biscuit with a little butter and perhaps a piece of cheese will be much better for you than a sweet biscuit.

4. **Breakfast foods**. These should consist of a choice between oatmeal and puffed oats, and any of the many makes of wheat or corn flakes, biscuit cereals, puffed grain or cereal for boiling.

5. **Fresh Meat**. The following are suggestions for various cuts: beef fillets, beef ribs, beef sirloin, beef shin, corned roll, frying pieces, ox kidneys, ox tongue, ox tail, silverside, sweetbreads, bladebone steak, chuck steak, fillet steak, minced steak, porterhouse steak, rump steak, topside steak, belly of pork, loin of pork, pig's fry, pork chops, pork fillets, pork undercuts, leg of pork, shoulder of pork.

Sheep's brains, breast of mutton, chump chops, forequarter chops, neck chops, loin chops, rib chops, loin of mutton, leg of mutton, neck of mutton, sheep's tongues, shoulder of mutton, lamb chops, lamb cutlets, leg of lamb, loin of lamb, shoulder of lamb, lamb's fry.

Calves' brains, calves' livers, calves' skirts, calves' tongues, neck of veal, veal cutlets, loin of veal, veal leg, veal shoulder, veal steak.

For those who have many mouths to feed on a little income, corned roll, chuck steak, pig's fry, belly of pork and breast of mutton are the most economical forms of meat to buy.

Other meats are ham, bacon, giblets, rabbits, poultry and game.

6. **Sausages and prepared meats**. Beef sausages, black puddings, brawn, Devon sausage, Frankfurters, garlic sausage, ham sausage, pork fritz, pork sausages, veal and ham sausage, veal sausage, veal and pork sausages, veal and tongue, white puddings.

7. **Tinned fish**. Herrings in tomato sauce, crab, pilchards, salmon and sardines, kippers, kipper snacks.

8. **Dried fish**. Bloaters, cod, haddock, herrings, kippers, ling fish, salmon.

9. **Pastes**. Marmite or a similar product, peanut butter, cheese pastes, lemon butter.

10. **Fresh fish**. Eels, soles, herring, salmon, mackerel, cod, skate, whiting, etc.

11. **Dairy products**. Milk, cheese, butter, eggs, ice-cream, and cream.

12. **Fruits (for vitamin C)**. Oranges, lemons, mandarines, pineapple, strawberries, grapefruit.

13. **Vegetables (for vitamin C)**. Potatoes, tomatoes, fresh lettuce, green vegetables cooked without soda.

14. **Other fruits**. Bananas, peaches, apricots, custard apples, rock melons, apples, cherries, grapes, nectarines, pears, plums and various sorts of berries. These fruits also contain vitamin C but usually not so much as those mentioned in the group above. They also contain some vitamin B and the yellow ones contain carotene the precursor of vitamin A.

15. **Vegetables**. Carrots, string beans, broad beans, cabbage, lettuce, spinach, pumpkin, celery, radishes, parsnips, parsley, Brussells sprouts, cucumber, cauliflower, kale, purple sproutings, eschalots, leeks, onions, peas, silver beet, tomatoes, turnip tops, watercress.

16. **Dried vegetables**. Lentils, lima beans, split peas. These are probably one of the cheapest sources of calories one can buy, add them to your stew made from breast of mutton and you will have a cheap and highly nutritious dish.

17. **Dried fruits**. Apricots, peaches, dates, figs and raisins. These are also an economical source of energy but they contain practically no vitamins and their energy value is due chiefly to their sugar content, and their part in the diet should therefore be a minor one.

18. **Tinned fruits**. If these are properly canned they should contain almost as much vitamin as the fresh fruit. Types which could be purchased are apricots, cherries, pineapples, plums, prunes, peaches, quinces and pears, but they provide calories in an expensive form.

19. **Nuts**. These contain second-class protein and fat and provide a fairly cheap form of energy, they could also be added to stew or curry.

How to obtain the elements required from the foods quoted

The daily diet should include first-class protein, some animal fat, a certain amount of carbohydrate (either sugar or starch), vitamins A, B, C, D and E, and minerals including, principally, phosphorus, calcium and iron. Let us take the first of these. You can get your first-class protein from groups 5, 6, 7, 8, 10 and 11. Animal fat is best obtained from group 11, although groups 5, 6, 7, 8 and 10 will provide some. Carbohydrate you can get from 1, 2, 3, 4, principally, but some may also be obtained from 14, 15, 16, 17, 18 and 19. Vitamin A is obtainable from 11 and the yellow members of 14 and 15. Vitamin D you can get from exposing your body to sunlight or from any of the members of group 11. Vitamin B can be obtained from the wholemeal items of groups 1 and 4, from groups 5 and 19, and from the green members of group 15 or from Marmite. Vitamin C can be obtained chiefly from groups 12 and 13, and in smaller amounts from groups 14, 15 and 18. Vitamin E you can obtain from the wholemeal members of groups 1 and 4 and from the green members of group 15, particularly lettuce. Phosphorus and calcium are obtained in the best proportion from the dairy products group, 11. Iron can be obtained from the meat group and the green vegetable group.

Let us now take a sample menu for the day's nutrition.

Breakfast

Vitamin C:—Glass of orange juice, pineapple or tomato juice, or a grapefruit.

Vitamins A, B, D and E; carbohydrate; calcium and phosphorus:—Cereal (whole) with plenty of milk.

First-class protein; iron:—Dried or fresh fish, a cutlet, sausages, or liver.

or

First-class protein; animal fat; vitamins A and D; calcium, phosphorus and iron:—Eggs and bacon.

and/or

Carbohydrate; animal fat; vitamins A and D (small amount only):—Buttered toast.

11 o'clock

First-class protein; properly balanced calcium and phosphorus; vitamins A and D:—Glass of milk (hot or cold).

Luncheon

Vitamin B (bread and Marmite); animal fat, vitamins A and D (butter); vitamin C (tomato and lettuce); vitamin E (bread and lettuce); first-class protein, animal fat, vitamins A and D (cheese and eggs):—Slice of sausage with lettuce and tomato; or sandwiches made of the same materials using wholemeal bread; sandwiches of butter and Marmite, or peanut butter with lettuce and tomato, or cheese or lettuce or egg sandwiches.

Carbohydrates:—Small piece of cake or biscuit.

Carbohydrate and vitamins, principally C, A and B to a smaller extent:—Fresh fruit: bananas, plums, peaches, apples, oranges, cherries, various berries, etc. (alone or with cream).

First-class protein; animal fat; vitamins A and D:—Glass of milk.

4 o'clock Tea

For food value of sandwiches see above; for milk see above; carbohydrates; animal fat (cream cakes); vitamins A and D:—Sandwiches as above; cream cakes; iced milk in the summer.

Dinner or Supper

Vitamin B from Marmite; carbohydrates and second-class protein from the other soups:—Marmite broth, or lentil soup, pea soup or bean soup.

First-class protein and iron, and vitamin B from the meats; carbohydrates, vitamins C and B from the vegetables; vitamin A from pumpkin:—Meat, fish, liver, with potatoes, pumpkins, peas or beans (all cooked without soda), or for a cold dinner, cold meat or sausage with potatoes mashed with milk and butter, and lettuce, tomatoes, celery, radishes or any other salad vegetables.

Vitamin C; phosphorus and calcium; animal fat (from cream and ice-cream); carbohydrates:—Stewed fruit and egg custard; fruit salad and cream or ice-cream; tinned fruit and cream or ice-cream; fruit pie and cream; fresh fruit and cream.

Late Supper

Vitamins C and B from apple; also carbohydrates; see above for food value of glass of milk:—An apple and a glass of milk.

It is not necessary to keep entirely to this menu. Some people do not care for a big breakfast; some like a small lunch. Cooking can be a much easier business than it used to be; there is no real need to waste time and fuel making cakes and biscuits and heavy puddings. Remember that a feeling of hunger may result from vitamin starvation and not only from calorie starvation. Curing a vitamin starvation by consuming large quantities of concentrated carbohydrates will only lead to the deposition of fat in the body and will not alleviate the starvation at all. Concentrate in making up your menus on those foods which contain first-class protein, vitamins A, B, C, D and E, animal fats and the minerals iron, calcium and phosphorus.

Diet in Slimming

Slimming by diet can be a dangerous process unless care is taken, since it is very easy to induce vitamin and other deficiencies. It is unwise to slim too rapidly, because this weakens the resistance of the body to infection. It is also unwise to use drugs for this purpose. Some drugs are composed of thyroid-gland extract, and it is extremely unwise to tamper with the endocrine system by taking such products; others have been found to cause blindness due to the formation of cataracts in the eyes of the women who have used them. There are some persons who are naturally very obese, and for such people to slim by diet and exercise, a great deal of will power is required. The moment such persons revert to an ordinary diet they rapidly regain the weight lost. The weight to aim at, is that at which you feel happiest and healthiest. There are many people, however, who would benefit considerably by the judicious curtailment of their diet and the addition of a little exercise to their daily routine. The following is a recommended diet for reducing.

Breakfast

	cals.
½ pint of milk	172
1 slice of wholemeal bread (fresh or toasted)	100
1 egg	82
Butter for toast (½ oz.)	110
½ grapefruit or 1 glass of orange pulp	60
Total	524

Lunch

	cals.
½ pint of milk	172
Sandwiches:	
1 tomato (½ slice of bread)	
1 cheese and lettuce (½ slice of bread)	
1 marmite or peanut butter (½ slice of bread)	
1½ slices of bread required for sandwiches	150
½ oz. of butter for the sandwiches	110
1 apple	40
1 oz. cheese for sandwiches	100
The calories of Marmite and tomatoes in amount used in these sandwiches would be negligible	
Total	572

Dinner or Supper

½ pint of milk. Either alone	172
or mixed with an egg to form a custard	254
1 cutlet (veal, or lean lamb, or mutton)	100
or a piece of fish in batter (fried)	120
4 oz. of mashed potatoes	100
2 oz. green peas or beans (cooked without soda)	40

If the milk is taken as a drink instead of as a custard take fruit salad with ½ oz. of cream.

Fruit about	80 calories
Cream	50 calories

4 oz. of cheese or 2 sausages may be taken instead of the cutlets if desired. If the milk is taken as a drink and the fruit salad and cream is eaten this meal will provide 542 calories. If the milk is taken as a custard and the fruit salad and cream is not eaten this meal will give 492 calories. It should be noted that 4 o'clock tea should not be taken at all. A cup of tea would be all right but nothing to eat. The total number of calories which you will obtain per day from this diet will be between 1600 and 1700. Now if you deduct this from your total calorie requirement of 2800 you will find that your body has to make good a deficiency of 1100 calories so that it should lose about ¼ lb. of weight per day, that is, nearly 2 lb. per week. A month on this diet should make a difference of about half a stone to your weight. This is a safe, pleasant and easy way to reduce. The foods are properly balanced and you should find yourself in good health at the end.

Letters from Readers

"Mr Tompkins": A Query

A FEW of us who are interested in physics have been discussing Professor Gamow's article in the December issue of *Discovery*—"Mr Tompkins in Wonderland. Dream I: Toy Universe."

We are rather troubled by his statement on p. 435, namely:

"If the rays of light travelled along the meridians, you, being for example located on the pole, would see the person going away from you growing smaller and smaller only until he crossed the equator.

"After this point, you would see him growing larger and it would seem to you that he was returning, going, however, *backwards*. After he had reached the opposite pole, you would see him as large as if he were standing by your side."

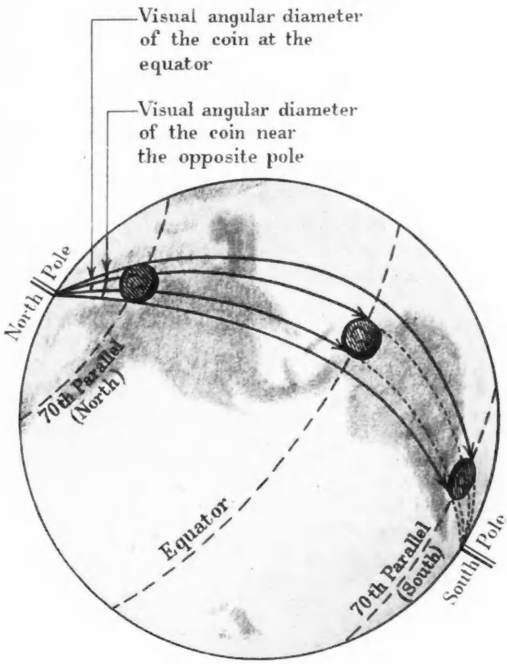
Now, it seems to us, that the person should appear to grow smaller and smaller *all the way* until he reached the starting point.

We would be glad if you would put this point to Professor Gamow for more lucid explanation.

W. J. GEALE, Kuala Krai, Kelantan. Unfederated Malay States.

(*We sent this letter to Professor Gamow, whose answer is given below.*)

SUPPOSE that the light is propagated on the surface of a sphere along the shortest distances, i.e. along the arcs of great circles. The rays of light from the north pole will thus coincide with the meridians. If you place a coin on a globe and move it from the north pole, through the equator towards the south pole, the angle between two meridians enclosing the coin will first decrease, but after the coin has passed the equator it will start to increase (see figure). Thus the "visual angular diameter" of the coin, as seen from the north pole, will *increase* when the coin approaches the

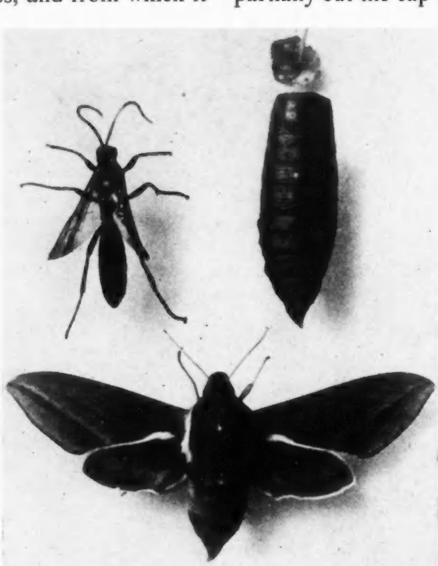


opposite pole. When we judge, as we are accustomed to, the distance of an object by its angular diameter, it will *seem to us* that the coin started to approach us again after it passed the equator, although, in fact, it is still receding. However, we shall always see the "back edge" of the coin (it has not turned over) and shall be under the impression that it approaches us backwards.

Small Eggar Moth

MR MALLINSON's letter in the March number of *Discovery* records the interesting fact that a specimen of the Small Eggar (*E. lanestris*) emerged naturally through the side of its cocoon instead of through one end, which, I venture to maintain, is the normal position of exit.

I do not quite follow Mr Mallinson's remarks about sawflies, and from which it might be inferred that a sawfly cocoon had been mistaken for a *lanestris* cocoon in spite of the fact that the cocoon contained an empty pupa case of *lanestris*! Though I have not made a study of sawflies I am familiar with the type of sawfly cocoon to which Mr Mallinson refers, and in which a circular cap is uniformly cut by the fly before emergence. The circular cap of a *lanestris* cocoon is not uniformly cut, but has an uneven edge as can be seen in the photograph "B" published last month. Through the kindness of a fellow entomologist who obtained the larvae, I have been able to rear a number of this species and all have emerged by pushing out a circular cap at one end of the cocoon. Mr Mallinson points out that a moth is unable to *cut* a circular cap, but he seems to overlook the fact that a pupa may be able to do so. The following is an extract from *The Lepidoptera of the British Isles*, by C. G. Barrett (vol. III, p. 11), relating to *lanestris*: "When the moth emerges a lid is pushed off at one end of the cocoon, having been to all appearances carefully cut partially through from the inside by the pupa for the purpose."



I am not sure whether the cap is in fact cut by the pupa of *lanestris* as Barrett suggests, since I have been able to detach a cap from the end of a cocoon in which the pupa had died. This seems to indicate that a circular line of "weakness" may be left in the fabric of one end of the cocoon by the larva when spinning it, to enable the moth to push the cap open. On the other hand, the pupa referred to may have partially cut the cap before it died. At any rate it is clear, I think, that *lanestris* does not merely *push* its way through a hole in its cocoon, made perhaps by means of a softening fluid, as certain other moths are known to do, e.g. the puss moth.

It would be interesting to know whether other entomological readers of *Discovery* have known *lanestris* to emerge from the side of its cocoon, or whether Mr Mallinson's example is as unusual as I believe it to be.

E. S. A. BAYNES, F.R.E.S., Guildford.

I WAS very much interested in the letters published in the March number of *Discovery* on the cocoons of the Small Eggar and the sawfly, and the mention that Mr Mallinson, your correspondent, made about ichneumons cutting off the tops of cocoons when emerging from them. A year or two ago, I bred a number of elephant hawk moths (*Chaerocampa elpenor*), all of which emerged in the usual way except one which proved to have been attacked by an ichneumon in the larva state. The full-grown ichneumon was

running about the breeding cage, having most neatly cut off the top of the pupa case as it emerged. The photograph opposite shows the imago of another elpenor moth and the ichneumon itself.

D. W. DARWALL, M.A., Warrington.

Two Problems

I WONDER if any of your readers could answer either of these problems for me:

(1) We used to think that matter was made of electrons and protons. Now we have found positive electrons, etc. If, on a distant star or on another galaxy, one had a preponderance of light positive charged particles and heavy negative ones, could not one then get chemical atoms the absolute opposite of ours so that even their spectra would not enable us to suspect there was any difference between them and ours? One would expect that, if it did exist, we should have suspected the existence of such a state of affairs from some meteor: but it might be that some other star galaxy was so constituted.

(2) Some years ago some work was done on liquefied ammonia as a solvent, and it was, I believe, found to be curiously like water in giving ionized solutions, etc. Would it be possible to get, say on the planet Jupiter, a weird kind of life in which ammonia took the place of water and a carbon to methane cycle took the place of our carbon to carbon dioxide cycle? At that temperature and with that reaction as its means of utilizing the sun's rays, it would be a sluggish type of life, but, it seems to me, not entirely out of the question. To this type of life, probably our oxygen would be as distasteful and poisonous as their ammonia methane atmosphere would be to us.

C. DUDLEY LANGFORD, Girvan, Ayrshire.

[Both these fascinating ideas appear to raise no theoretical difficulties:

(1) Atoms the exact opposite of ours certainly could exist, and would be completely indistinguishable in all respects. It is possible to imagine a stellar universe built up of such atoms. There would be one interesting result. If such a universe ever came into contact with our own, both would instantly disappear.

(2) This ingenious suggestion is probably the only faint hope of anything like "life" on Jupiter.

EDITOR, *Discovery*.]

Colour in Painting

IN the instalment of "Colour in Painting" in the March issue of *Discovery*, I made a stupid slip of the pen, writing (at foot of p. 142 and top of p. 143) of Rembrandt's avoidance of the non-spectral *colours*. This makes nonsense of the sentence that follows, in which I stated: "but neither does he use brown". Brown, of course, is a non-spectral colour. Following my usual terminology, I ought to have written "non-spectral *chromata*", meaning purple, violet, etc.

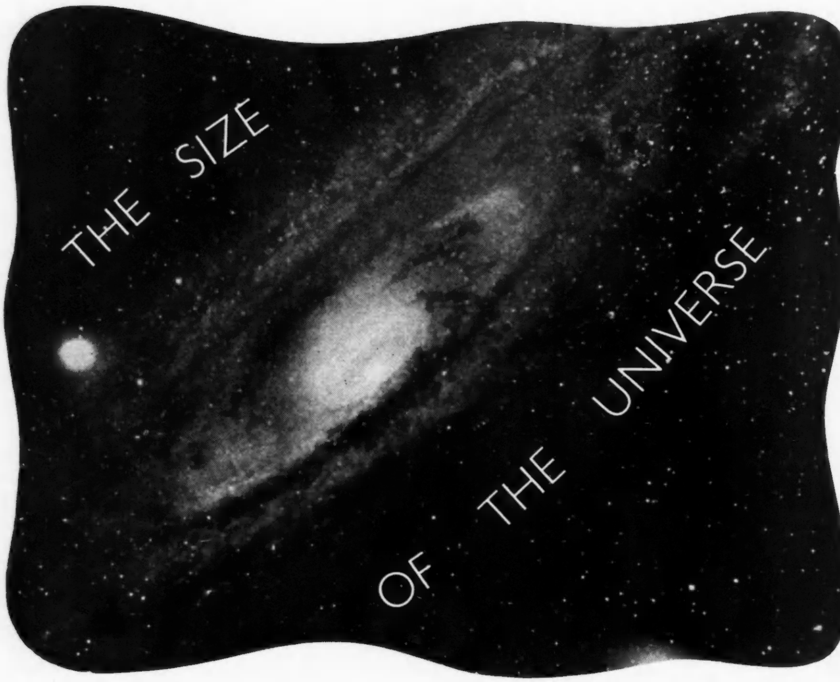
MARY BARNE, Bloxham, Oxon.

Professor F. G. Donnan, C.B.E., F.R.S., formerly professor of chemistry at University College, London, and the present President of the Chemical Society, has been elected President of the Association of Scientific Workers, in succession to Professor Sir F. Gowland Hopkins.

His election is particularly appropriate as he has always been interested in problems affecting the status of scientists, and the applications of science to industrial development.

A series of meetings has been arranged by the Social and International Relations of Science Division of the British Association, at which topics of immediate interest and importance are to be discussed. The first of these meetings was held on 28 March, at Reading University. The Chairmen were Sir Richard Gregory and Sir Daniel Hall, and the meeting was devoted to discussion on milk and its nutritional and allied aspects.

INVITATIONS TO KNOWLEDGE. I



By MICHAEL LORANT

SINCE the invention of the telescope, technology has created more and more powerful instruments for observation, so that the picture of the universe about us has become clearer and clearer. To-day, with the aid of the triumphs of optics and fine mechanics, the scientist photographs and measures the stars.

To us, our earth appears to stand still in one place. Formerly, it was believed that the earth was the fixed centre of the universe, and that the sun, moon and planets moved around it in harmonic motion.

It was Copernicus who first proclaimed the sun to be the queen of the planet world. He it was who allotted to our earth its place as a simple planet. The sun, only one star of multitudes, is almost inconceivably immense. If each of the little balls in Fig. 1 represents a body the size of the earth, then one million of them would be needed to fill the bigger ball which represents the size of the sun.

How far are the stars away from our earth? To convey an idea of the distance in miles is impossible. We need some other standard of measurement. Let us imagine that an express train travels at 70 miles an hour. Moving at this speed day and night, without stopping, the train would take 16 days to make one journey round the earth, that is to say, a distance of about 25,000 miles. If the train kept on for something more than seven times round the earth, it would have covered a distance of 186,000 miles and taken more than a quarter of a year. For this entire distance, *light would have needed only a single second.*

Accordingly, 186,000 miles are one light-second. That is the unit of measurement in

which astronomers calculate. For example, the distance from the earth to the moon is somewhat more than one light-second. The distance from the earth to the sun is almost 400 times as great as that to the moon. That is to say, the rays of light take about 8 minutes from the source on the sun to our eyes on earth. That brings us to calculations in light-minutes.

The substance of this article will be familiar to some readers of Discovery. *In developing the policy mentioned in this month's editorial, we propose to devote one article each issue to a striking presentation of some fairly simple scientific topic. We hope in this way to stimulate the curiosity of some of our younger readers.*

The most distant planet is Pluto. He is $5\frac{1}{2}$ light-hours away! Let us suppose now that we move away from our solar system into the universe of space. On we go through a vacuum—nothing but emptiness, except for cosmic rays, cosmic dust, and occasional fragments of matter.

The nearest fixed star visible to the naked eye is Sirius. To reach it, we should need not hours, not even months, but 9 full years! A comparison will perhaps make the inconceivable immensity of such distances more intelligible.

It is well known that *wireless waves travel at exactly the same velocity as light*. In 1927 wireless waves with the velocity of light conveyed into outer space the news of Lindbergh's flight across the Atlantic. Only in 1936, 9 years later, did this news reach Sirius, which is 9 light-years distant.

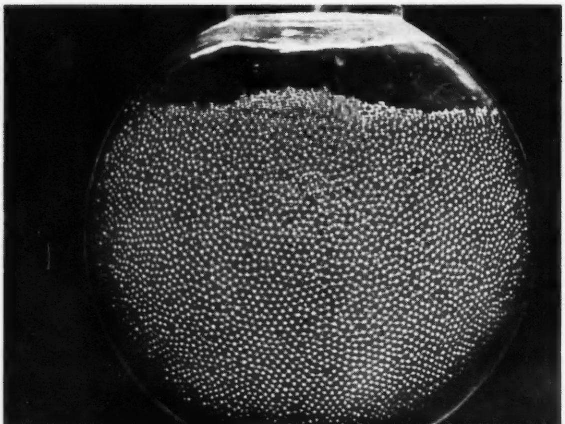
Farther on, we pass millions of stars, gigantic incandescent suns. Many stars are grouped in such a way that, seen from the earth, they constitute definite constellations. There is, for instance, the Great Bear. The chief star of this group is about 80 light-years distant from us. Then there is the constellation Scorpion, the light from whose most brilliant star only reaches us after 360 years. The Orion group is between 500 and 600 light-years away. That is to say, the light from this constellation reaching us to-day had already been on its way for 150 years when Columbus discovered America.

One of the most beautiful sights of the starry firmament is "The Milky Way". It girdles our whole earth. You can see for yourself what the Milky Way is—a system of many millions of stars. Our sun is nothing more than a minute point in this limitless Milky Way. Some individual stars of the Milky Way are situated at great distances from us. Some collections of stars in the Milky Way are 2000 light-years away. That is to say, the light by which we see some of the Milky Way now had left there before Christ was born. How is the Milky Way constituted? As we ourselves are right in the middle of it, we cannot photograph it from outside. Astronomers, however, have given us an idea of its shape. According to this account, the Milky Way, in its entire form, resembles a lens. The diameter of the Milky Way is about 100,000 light-years.

Our sun with its earth, as already said, is nothing more than a minute particle in the Milky-Way system. All of these stars race through the universe in accordance with eternal laws. Instinctively one thinks of collisions. There is no need for anxiety. Despite these many millions of stars the universe is so vast and the separate stars so far distant from their nearest neighbours that to all intents and purposes the universe is an empty space.

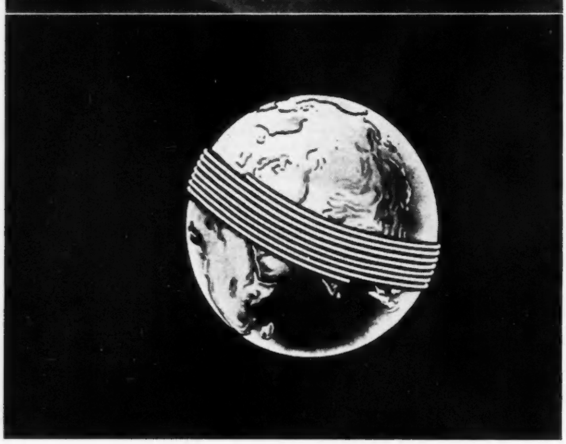
Imagine that up in the frozen seas off Greenland a small rowing boat is set adrift, and a second one at the southern extremity of Africa. Naturally on the diagram the boats appear out of all proportion to their true size. But you know quite well how small they are in reality. Now the likelihood of these two nutshells colliding in the Atlantic Ocean is no greater than that two stars would ever come into contact, despite

(*The rest of this article is on page* 206.)

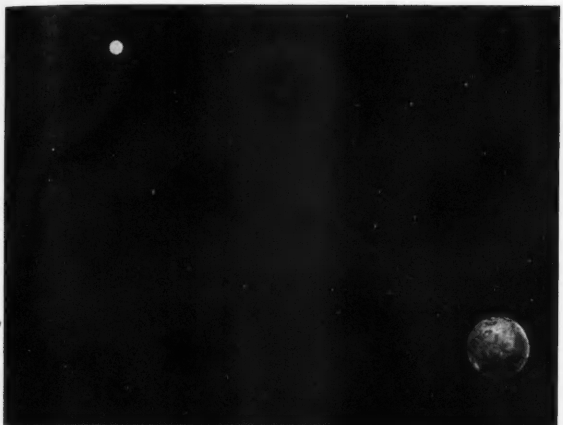


1. *If each one of these little balls represented the size of the earth, no less than one million of them would be needed to fill up the body of the sun.*

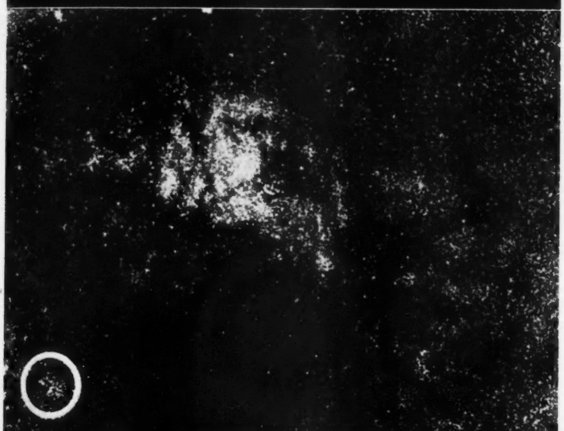
2. *An express train, travelling at 70 miles an hour, and moving at this speed day and night without stopping, would take 16 days to complete one journey round the earth, a distance of about 25,000 miles. (Do not be misled by the figure into thinking that trains travel round the earth on their sides!)*



3. *If the train kept on travelling just over seven times round the earth, it would have covered a distance of 186,000 miles, and have taken more than a quarter of a year. For this entire distance, light would have needed only a single second. Therefore 186,000 miles are one "light-second", which is the unit of measurement in which astronomers calculate.*

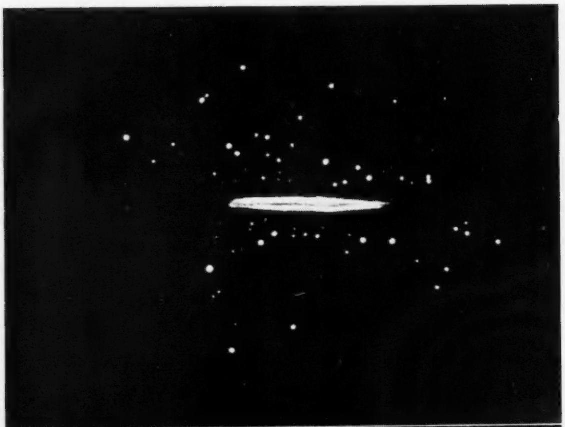


4. The distance between the earth and the moon is somewhat more than one "light-second".



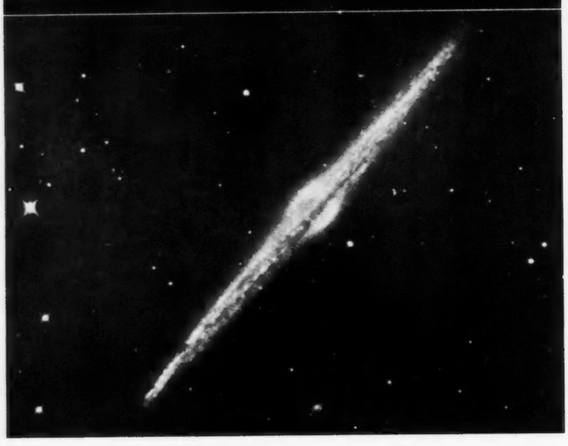
5. The Milky Way is a system of many millions of stars; some of the individual stars of which are situated at great distances from us, although the sun itself belongs to the Milky Way. The mass of stars grouped into a ring in the picture is 2000 "light-years" away from the solar system.

6. If one rowing boat set off from Greenland and another one set off towards it from the southern extremity of Africa, the likelihood of the two colliding is no greater than that two stars would ever come into contact.



7. *Around the Milky Way there are some sphere-shaped clusters of stars; of these, the farthest away are 100,000 "light-years" distant from the earth.*

8. *Far beyond the Milky Way there are many more of the same systems and as great, or even greater ones, than those which can be seen with the naked eye.*



9. *Another star system far beyond the Milky Way.*

10. *Millions of suns make up the Andromeda-mist. They hang suspended in space a million "light-years" away. Every one of these many "Islands of the Universe" is a Milky-Way system of many millions of stars.*

A. This photograph of lunar craters shows, on the extreme right, the crater Plato, which has a diameter of 60 miles. The range of mountains between this and Cassini, at the bottom of the photograph, is 12,000 ft. high. To the left above Cassini is Aristillus, whose diameter is 34 miles. The crater above this, a part of which only can be seen, is Archimedes, whose diameter is 50 miles.

B. This is a slight enlargement of the same photograph of craters shown at a different angle.

the fact that the stars are moving through space with a thousandfold the velocity of the fastest express train known.

But astronomers have ascertained still more. Around our Milky Way there are sphere-shaped clusters of stars. The farthest away are more than 100,000 light-years distant!

The light reaching us now from these star clusters began its long journey when the mammoth still wandered about the earth. The light raced on during the whole prehistoric period when lake-dwellers were living in Europe, continued its flight through the whole historic epoch. The pyramids were built—Athens—and Rome flourished and declined, the Mediterranean became great, the light all this while rushing on uninterruptedly at the rate of 186,000 miles per second and only reaching us now.

But far, far beyond these star clusters our astronomers have discovered more star mist. And this mist is nothing more nor less than other Milky-Way systems, as great as ours or even still greater. Here, for example, are the millions of suns that make up the Andromeda-mist. They hang suspended in space a million light-years away. Every one of these many "Islands of the Universe" is a Milky-Way system of many millions of stars, and of such Milky-Way systems millions and millions have already been discovered.

Reviews

The Future of Secondary Education

A Review of the Spens Report

It may be said generally that the changes in educational method and administration during the present decade—especially the division of "elementary" education into primary (up to age 11+) and post-primary (11+ to 14 or 15), with the establishment of senior or "modern" schools in towns and country areas—have in the main left what is termed "secondary" education untouched. That is to say, the State-aided Grammar Schools of the municipal or county type, as well as the Foundation Schools which enjoy a government grant, have remained a separate entity, with a curriculum that has changed in nothing but minor details since the introduction of the School Certificate in 1917. The reason is not far to seek. When the Certificate Examination was inaugurated, it was regarded as "a cardinal principle that the Examination should follow the curriculum and not determine it". But the practice of twenty years has only resulted in the complete violation of the principle. In the secondary schools of to-day the curriculum is largely determined and controlled by the syllabus of examinations administered by the various Universities. The result has been an academic bias that has gone far towards discouraging education in its broader and more liberal sense. It is not any wild exaggeration to say that the schools have, willy-nilly, become mere forcing-houses or—as some put it, even less politely—cram-shops. Teacher and pupil alike have become the victims of a system which has given them for their birthright only a mess of pottage.

What is admittedly a difficult problem has been tackled with both vision and

courage by the recent Report on Secondary Education, popularly known as the Spens Report. While visualizing all post-primary education as essentially one, the Report deals, according to its terms of reference, only with that which lies outside the control of the present elementary code. It stresses, with an admirable freshness of outlook, the importance of an education that would render the pupil alive to the realities of life. "Before everything else", it says, "the school should provide for the pre-adolescent and adolescent years a life which answers to their special needs and brings out their special values." In other words, education should be a vital thing—not, as it so often is, a mere academic exercise—but developing every side of the character, physical, mental and moral. The Report reasserts the principle of "the English compromise between State regulation and freedom of teaching", if education now and in the future is to be the foundation and bulwark of our democratic ideal. Since a country has everything to gain "from the free growth of individuality among its potential citizens", the school "fulfils its proper purposes in so far as it fosters that growth, helping every boy and girl to achieve the highest degree of individual development of which he or she is capable". And that growth would be associated with a "national tradition", under which the schools foster the "special traits of the English character at its best" and cherish all that is admirable in English art and literature. The living world of the school, not merely as a "place of learning" but also as a social, if artificial entity, would be the training ground for the citizens of to-morrow in the greater world outside.

Now all this is a tolerably familiar doctrine, though the emphasis on the "national tradition" is a little unusual, not to say reactionary, and can best be regarded as a counterblast to the rabidly nationalistic methods of education in the totalitarian states. But the Report does not stop short at the expression of mere pious hopes; it points the way to the realization of its own ideals. Its keywords may be stated in general as "vitality" and "individualism"; and their implications, in the reform of the existing type of secondary education, are far-reaching and highly significant. To begin with, the old ideas of a somewhat nebulous "all round training of the faculties" and a "'liberal' education which corresponds neither to the circumstances of the pupils nor to the needs of modern civilization" has to be drastically revised. The common tendency to adjust the pupil to a fixed curriculum instead of the curriculum to the pupil is a pernicious one, especially in its relation to the "non-academic" type of boy or girl. If—and here is the central pronouncement of the Report—the curriculum "should be thought of in terms of activity and experience rather than of knowledge to be acquired and facts to be stored", it follows that within reasonable limits it must be variable, that is, it must be suited to the needs and interests of the necessarily differing types of pupil. Hence there would have to be a far more elastic method of grouping subjects, or, as the Report prefers to call them, activities. The old heresy that "it does not matter what you teach a boy so long as he dislikes it" must be thrown overboard for ever; since interest, and not dislike, is the very essence of that creativeness and aesthetic appreciation which is at the root of all real teaching.

The Report, therefore, proceeds to review the various "subjects" (to use the old term with a difference) in the light of its argument that, in any true system of education, the pupil would play a far more active part than he does at present. It would make the understanding of the mother tongue—the ability on the part of the child "to express clearly, in speech or writing, his own thoughts, and to understand the clearly expressed thoughts of others"—the core of the curriculum. With that would go "training in the appreciation of English literature, the encouragement of a love of reading, joy in the discovery of literary beauty, enlargement of imaginative experience". The traditional method of

teaching Latin through the study of "formal and abstract grammar" is deprecated in favour of a method "based on the reading of Latin and the close and intelligent study of the live word functioning in a live context". In the teaching of Mathematics and Science much more emphasis should be laid on the relation of these "subjects" to modern life. They should, in effect, become real activities, not mere mental exercises or academic experiments. Science "must deal with the pupil's own experience and, on the basis of that experience, extend through interest his horizon". The traditional divisions of Mathematics—arithmetic, algebra, geometry, trigonometry—should go; mathematics should be taught "as a science in which the topics are chosen so as to develop a grasp of mathematical ideas, and these topics should be suggested and introduced by the examination of practical questions which in their day have been of urgent interest and utility to man in his affairs". And as a background to all the activities of what we may call the ordinary curriculum, as well as to the social life of the school, there should be the definite moral training that comes from an intelligent and reverent study of the Bible under a specially qualified teacher, and the aesthetic creative experience associated with Handicrafts, Art, and Music, all of which should hold a position of greater importance than at present in the school timetable.

The Report recognizes that even in the "Grammar" Schools provision ought to be made for concrete and semi-technical activities, to meet the needs of certain pupils; without, however, the introduction of any "subject" that might be deemed narrowly vocational. It goes further, and suggests the establishment of a type of school hitherto unknown in England, which it calls the Technical High School. This would be a development of the present Junior Technical or "Trade" School, and "should be accorded in every respect equality of status with schools of the grammar school type". The new schools would "be housed in the premises of Technical Colleges and Technical Institutes", so that every advantage could be taken of the equipment available in such institutions, and of the stimulating atmosphere created by buildings and staffs also concerned with adult education. In brief, the Report carries its attack on the indiscriminate provision of lifeless and arid academic training for pupils who have no hope of profiting by it to a practical and logical conclusion.

There remains the problem of examinations; and here the Report falters. For the new Technical High Schools it suggests an internal examination, set and controlled by the school staffs, but liable to revision, in both the drafting and marking of the papers, by external assessors appointed by the Board of Education. Now this is excellent; but surely what is deemed to be good for the new should be good also for the old. Yet the Report leaves the examination of the "Grammar" Schools in the hands of the Universities, relying on the provision by the University authorities of modifications in the syllabus designed to assist the schools in realizing the new ideals of education which it sets up. In spite of the fact, however, that the Universities have already done something, and will perhaps do more, to bring their school examination schemes into conformity with modern ideas of education, it is doubtful whether the Grammar Schools will ever be free from the "academic" bias roundly condemned by the Report until they are also free from University control. Unfortunately, the Report refuses to go all the way; though only some such internal examination as is visualized for the new Technical High Schools would avail to ensure the fulfilment of its own recommendations for the Grammar Schools.

For an independent examination system, controlled by the Board of Education, would give the schools a new outlook, and unfetter them from a tradition from which they have suffered too long. It would solve another problem. According to statistics

in the Report, only about 15 % of the pupils in the Grammar Schools pass on to the University—and in individual schools the percentage is much lower. Why not, therefore, administrate for the 85 %, and let the aspirants to the University take, at will, the examinations the University provides for them? At one blow, the unfortunate association of Matriculation with the General School Certificate would go—far more effectively than it can ever go, in spite of official decrees, while the University examination for the leaving Certificate remains. The great majority could then sit for the internal examination at 16 and, probably, for a higher examination at 17. Incidentally, the present problem of the "one-year" sixth form would be solved. Meanwhile, the minority proceeding finally to a University degree could take the existing external University examinations (as they did before 1917), or some new type of examination could be provided for them by the Universities themselves. After all, the necessary adjustments to and variations in the curriculum are already foreshadowed and recommended by the Report. Once the desirability of examinations is granted, it is necessary to ensure that they should induce, as far as possible, a reasonable freedom in educational methods, and interfere as little as possible with the wider social life of the schools. In these particulars, the present system of examination by the Universities has failed; and it is not unfair to prophesy that, in spite of modifications already in force and others proposed for the future, it will never be altogether satisfactory. The excellent ideals of the Report are, therefore, in danger of frustration by this one notable and fatal defect in the Report itself.

G. H. VALLINS

(*Discovery* allows its contributors complete freedom of expression. Their views therefore must not be taken as in any sense indicating the journal's. Mr Vallins writes from the point of view of a schoolmaster. We do not find ourselves able to endorse all of his opinions. EDITOR)

SHORTER REVIEWS

Wild Animals in Britain

FEW people in Great Britain can write of our mammalian fauna with the personal knowledge which Miss Frances Pitt brings to bear. She has observed most species in the wild state and has supplemented this acquaintanceship by keeping many animals as pets. Her present book* maintains this personal quality, being well furnished with anecdote and not oppressive as a mere compilation would be. The outstanding feature of the book is the large number of photographs of British mammals. Bird photography is now highly developed as a hobby and the ingenious man can obtain fine results without really becoming a naturalist. But animal photography is much harder and calls for closer study of habits and great patience. Most of the plates gathered by Miss Pitt and the Publishers show the animals in natural surroundings and in postures of ease, not fright. The coloured plates, after Millais, Wilson and Barret, are well produced. Several of Thomas Bewick's quaintly anthropomorphic wood engravings appear as tail pieces to the chapters and provide an interesting comparison with the twentieth-century techniques of illustration.

F. F. D.

* *Wild Animals in Britain*, by Frances Pitt. Batsford, 8*s*. 6*d*.

Fore-knowledge

THIS volume* belongs to a new series of books on psychical experiences. The author draws most of his material from the *Proceedings of the Society for Psychical Research*, but states that that Society is "in no way responsible for any of the deductions made, or theories advanced".

From a careful and conscientious perusal of the book, one cannot doubt the honesty, modesty and sincerity of the author, but, at the same time, his underlying love of mysticism, his will to believe what is dear to him and his want of scientific training are evident. As a psychical researcher he accepts telepathy as an established fact, ignoring the findings of experimental psychologists. In the penultimate chapter he enumerates four metaphysical theories which have been advanced by him and others to explain the alleged phenomena but, in the last chapter, he states that he is compelled to confess that none of these theories seems to him to be even provisionally acceptable. He believes that "the crux of the whole problem is Time and the nature of Time" and that "it is pretty certain that precognition is an affair of the subliminal mind". "We are bound to admit that the future does exist in some sense *now* at the present moment."

The comment of the sceptical psychologist is this: the negative cases which are legion are neglected and forgotten. A few positive cases are due to chance and most of the alleged positive cases to auto-suggestion and accidental falsification.

Ghosts and Apparitions

THIS is another book† of the "Psychical Experiences" series. These books are difficult to review critically. One is quite willing to postulate the good faith of the authors, though at times it may appear difficult. However, the general reader will exclaim with Faust:

"Die Botschaft hör' ich wohl, allein nur fehlt der Glaube."

"Das Wunder ist des Glaubens liebstes Kind."

The psychologist in discussing belief-engenderment recognizes two principles, a primitive one and a rational one. "The *primitive* principle can be briefly stated thus: *Man tends to believe in the reality of that which he strongly desires*; the *rational*, which is developmentally a higher principle, thus: *Man tends to believe in the reality of that which is compatible with, or at least not contrary to, the integrated mass of his acquired tested knowledge*" (Helge Lundholme: *The Psychology of Belief*, Durham 1936). Evidently percipients of ghosts and apparitions are suffering from hallucinations, and, being of the level where the primitive principle still obtains, accept them as a reality. There seems then to be a deadlock, as the phenomena are not amenable to experiment, for ghosts, apparitions and spirits appear notoriously to avoid the psychological laboratory.

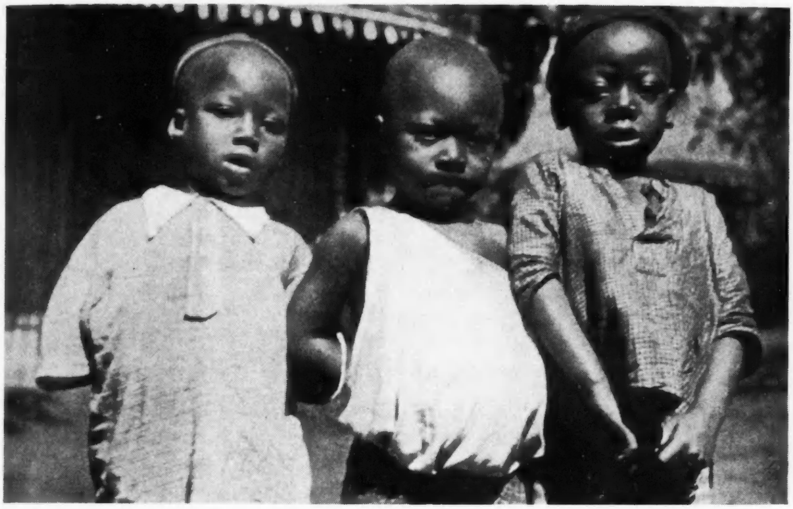
In the first chapter dreams are discussed. The second chapter deals with apparitions seen by percipients when awake. "The veridical element in dreams and apparitions" is the heading of the third chapter. This is certainly the most interesting chapter of the book, for the author refers to the report of a Committee on a Census of Hallucination in 1894 which came to the conclusion: "The death coincidences are therefore on this calculation 440 times as numerous as might be expected for chance" (*sic*). From the scanty details cited it is difficult to criticize, but the gathering of the populations, the evidential value of the material and the statistical method appear all to be open to the gravest objections.

The fourth and fifth chapters deal with Hauntings, Apparitions and Poltergeists.

A. WOHLGEMUTH

* *Fore-knowledge*, by H. F. Saltmarsh. G. Bell. 3*s*. 6*d*.

† *Ghosts and Apparitions*, by W. H. Salter. G. Bell. 3*s*. 6*d*.



Three of the Sons of the King of Bangangté

This photograph is one of many by F. Clement Egerton, reproduced in his book, *African Majesty: A Record of Refuge at the Court of the King of Bangangté in the French Cameroons.* (Routledge, 18*s.*)

Seen in the Hadhramaut

THIS is a most endearing book*: I loved it. Freya Stark is an enchanting photographer; she writes excellently, and what a traveller! One of the very few who will let you look through their eyes at beauty, desolation, crumbling civilizations and untouched lands without ever asking you to shorten your vision to the eyes themselves, considering their nobility and shrewdness. I have no doubt that hers are both noble and shrewd, if only because of the things she does not say: she says, in fact, so little, even about the Hadhramaut, in the first introduction she wrote to these 130 lovely pictures, that I am delighted her publisher was what she calls "impervious to reason" and insisted on her adding a great deal of interesting information as an afterthought, in a grudging but even more charming second-preface. Her "reason" was that "I have looked at picture books myself, and I know that no-one thinks of reading the introduction". Anyone who skipped Freya Stark would be missing phrases as fine as the scenes and particularly the architecture in her illustrations: "These pictures preserve in some measure what may soon be only a memory of the past, for these houses, decorated by leisure and created for defence, have no place in the modern world. One may think of them, taken in their strength and their beauty and placed upon our pages, as of those tall barbarians presented to civilisation in the Roman arena; they have come, with dazzled eyes, from their dim solitary freedoms and stand before an alien public with the unconscious dignity of those about to die."

Almost all her camera groups—her brilliant foregrounds, savage sunshine and tender skies—have the same effect of effortless achievement as that.

E. ARNOT ROBERTSON

* *Seen in the Hadhramaut*, by Freya Stark. John Murray, 21*s*.

Alone

"—the Barrier, austere as platinum—", says Admiral Byrd of the ice-range which shut him away from the rest of humanity for five months of Antarctic darkness. His account of this ordeal, *Alone*,* is also about as austere as that.

And yet it has a real and peculiar fascination, like anything written by T. E. Lawrence, with different selves of the writer taking over the authorship at intervals: it would be hard to say how many selves inhabited Lawrence, but Admiral Byrd seems to have two. Both are men of extreme physical courage. One of them has moral courage too. There are pages of unconvincing scientific argument to explain why one man, and he the person responsible for the whole Polar expedition, should have willingly immured himself in a hut 123 miles from his leaderless men as the enormous night closed down on the southern ice-cap: and suddenly interrupting, the second personality records with punishing frankness that really he did it because he wanted to, because he wondered how he would stand up to that appalling experience. And then, still more honestly, he adds that he was always aware of the risk involved to his men—the danger that, despite his orders to the contrary, they might make a desperate attempt to rescue him, through blizzard and almost unthinkable cold and darkness, if anything went wrong with him during that self-imposed sentence of solitary confinement and meteorology. As indeed they did.

I can readily imagine that anyone who served under Byrd II would be willing to imperil his life in getting this exceptional person alive out of the position in which Byrd I had placed him: the pity is that the latter could not be left behind. If this book proves anything, it is that from a prolonged sojourn face to face with his own soul, a man gets nothing but what he took into the examination room in the first place.

The examination room here was a shack with a faulty stovepipe. Fumes, not loneliness nor the hardships which he bore admirably, were the enemy that nearly killed him. It was impossible to live without warmth where the temperature sometimes dropped below -70, and the fight was to keep his nerve and his judgment and his fortitude balanced between the torments of cold and slow poisoning.

There are some notable light interludes, the best due to his inability to get flap-jacks whole out of the frying pan, however well he greased it. The complex miracle of modern communication was called to help. By careful relay after relay his wirelessed question journeyed from the bottom of the world to the centre of civilization. The highest authority was invoked, the chef of the Waldorf-Astoria in New York. By careful relay after relay the answer came back to him: "You must grease the pan."

But humour is not enough, and courage is not enough, and enforced austerity is altogether too much for anyone with a platinum taste for it who can write of his leave-taking, "There was no ceremony about it whatever, if only because Byrd expeditions never stand on ceremony." If Byrd II could have written this book entirely it might have been terrific, but then that Byrd would not have chosen to keep this vigil. Even for the little of the description that he did write, though, it is very interesting reading.

E. ARNOT ROBERTSON

* *Alone*, by Richard E. Byrd. Putnam. 7*s*. 6*d*.

This Is Our World

"I like to marvel," says Mr Lubinski early in his book, and in truth he marvels through nearly three hundred pages and in Iceland, Abyssinia, Turkey, Algeria, Siberia, Germany, Austria, Holland and North America. The book* consists simply of anecdotes connected with the author's travels; there is no attempt to delve deeply into international or scientific matters; and if Mr Lubinski is too fond of standing back and pointing to himself astride a camel or bucketing in a small steamer, he must be forgiven for the many amusing sidelights he displays. Not the least interesting is the fact that the Soviet ban on photographing "transport" extends to the restaurants in which railwaymen eat!

The best section is that devoted to Siberia. Mr and Mrs Lubinski made an extended tour through Kasakstan and the Altai Mountains, and paint an intriguing picture of the impact of the Soviet culture on primitive native life. The chapters dealing with Abyssinia and with Austria have an historical value, being accounts of visits before the coming of fascist rule, while the survey of modern Turkey provides a useful contrast of the benefits which may accrue from a dictatorship wisely administered.

Mr Lubinski's photographs are well known, and those included in this volume are both numerous and good.

R. W. KIDNER

* *This Is Our World*, by Kurt Lubinski. (Hodder and Stoughton. 15*s*.)

Select List of Books Received by *Discovery*

(*Mention in this list does not preclude review*)

A View of All Existence. ELYSTAN THOMAS. (Watts, 1*s*. 6*d*.)

Earthquakes and Other Earth Movements. A. W. LEE. (Kegan Paul, 10*s*. 6*d*.)

Everyman's Astronomy. MARY PROCTOR. (Scientific Book Club, 2*s*. 6*d*.)

The Making of Egypt. FLINDERS PETRIE. (Sheldon Press, 12*s*. 6*d*.)

Tools and the Man. Dr W. B. WRIGHT. (Bell, 12*s*. 6*d*.)

Cylinder Seals. A Documentary Essay on the Art and Religion of the Ancient Near East. H. FRANKFURT. (Macmillan, 42*s*.)

Electricity. T. F. WALL. (Thornton Butterworth Ltd., 2*s*. 6*d*.)

The Elements of Radio Communication. (Second Edition.) BROWN and GARDENER. (Oxford University Press, 16*s*.)

Manual of Sedimentary Petrography. W. C. KRUMBEIN and F. F. PETTIJOHN. (D. Appleton-Century Co., 30*s*.)

German-English Botanical Terminology. HELEN ASHBY, ERIC ASHBY, Dr HARALD RICHTER, Dr JOHANNES BARNER. (Thomas Murby, 10*s*. 6*d*.)

The Story of the Brain. E. M. FITZADAM-ORMISTON. (Heinemann, 7*s*. 6*d*.)

The Basic Mechanics of Human Vision. BROOKS SIMPKINS. (Chapman and Hall, 12*s*. 6*d*.)

The Social Life of Animals. W. C. ALLEE. (Heinemann, 12*s*. 6*d*.)

Birds as Animals. JAMES FISHER. (Heinemann, 12*s*. 6*d*.)

A Guide to the Snakes of Uganda. Capt. CHARLES R. S. PITMAN. (The Uganda Society, 30*s*.)

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